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The Engineer

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PUBLIC NOTICES

The Director - General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—

1. 536 TONS GALVANISED IRON WIRE.
2. 40 FLANGED COPPER FIRE-BOX PLATES for LOCOMOTIVES.
3. 10,000 SOLID-DRAWN STEEL BOILER TUBES.
4. 568 PAIRS of DISC WHEELS and AXLES and 1214 DISC WHEELS for RAILWAY WAGONS.
5. 11 STEEL LOCOMOTIVE CRANK AXLES.
6. 2800 LAMINATED BEARING SPRINGS for RAILWAY CARRIAGES and WAGONS.
7. BUFFERS and BUFFER PARTS.
8. 988 STEEL TYRES for LOCOMOTIVE, CARRIAGES and WAGONS.
9. 2800 CAST STEEL or MALLEABLE IRON AXLE-BOXES for RAILWAY CARRIAGES.
10. LOCOMOTIVE DUPLICATES.
11. 55 SLUICE GATES, MILD STEEL, 25ft. span, 3 tier, electrically operated, for Irrigation Feeder Canals.

Tenders due on the 14th December, 1926, for Nos. 1 to 3, on the 17th December, 1926, for Nos. 4 to 8, and on the 21st December, 1926, for Nos. 9 to 11.

Specifications and forms of Tender obtainable from the above at a fee of 5s. per set, which will not be returned. 4129

Assistant Engineers (9) REQUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT for two tours of not less than 12 nor more than 18 months' service in the first instance. Subject to satisfactory service, the officers appointed will be eligible at the expiration of three years' service for confirmation in the permanent and pensionable establishment. Salary, £480, rising to £920 a year. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, preferably between 25 and 30 years of age, unmarried, must have passed the examination for A.M.I.C.E., or possess a degree in Civil Engineering recognised by the Institution as exempting from parts "A" and "B" of the examination. They must have had proper technical training, and preferably have had not less than two years' subsequent experience on large Engineering or Municipal Works. Candidates possessing other Civil Engineering qualifications may apply.—Applications should be made at once by letter, stating age, qualifications, and experience, also whether married or single, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/14485 2973

Civil Engineer Required for the BAGHDAD WATER BOARD, IRAQ, for two to three years' service. Free passages and liberal leave on full salary. Salary Rupees 650 to 800 a month, according to qualifications and experience. Candidates, 23 to 26 years of age, unmarried, should have passed examinations for A.M.I.C.E. Diploma or possess equivalent professional qualifications and have had some practical training, preferably on waterworks.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, quoting M/14744. 4122

Civil Engineer Required by the GOVERNMENT of CEYLON for the APPOINTMENT as IRRIGATION ENGINEER for three years in the first instance. Salary £500, rising to £900 a year by annual increments of £40 (£800 on attaining 30 years of age). Free passages provided. Candidates, unmarried, age 26-31, must have passed the examination to qualify for Associate Membership of the Institution of Civil Engineers or hold equivalent professional qualifications, and have had at least three years' practical experience on waterworks, drainage or harbour and dock works.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting at head of application M/15030. 4119

Electrical Engineer - in - CHIEF REQUIRED by the GOVERNMENT of NIGERIA, to Take Charge, under the Director of Public Works, of the Development, Construction and Operation of Electricity Supply Matters in the Colony. Period of service two tours of from 12 to 18 months each, with prospect of permanency. Salary £1100 a year, plus a duty allowance of £220. Free quarters and first-class passages and liberal leave on full salary. Candidates, aged 30 to 35, must have had a good technical education and workshop training, with wide experience in the design and working of electricity supply undertakings. Colonial experience is desirable and good administrative ability essential. They should possess an engineering degree and preferably be corporate members of the Institution of Electrical Engineers.—Apply at once by letter, stating age and particulars of experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/14912. 4121

Indian State Railways. The High Commissioner for India is prepared to receive APPLICATIONS for the following APPOINTMENTS :—

(A) THREE ASSISTANT WORKS MANAGERS Senior Scale). Qualifications, ability to reorganise a large works system and lay-out with a view to improve output and reduce costs; ability to initiate and control planning, rate fixing, progress inspection and costing departments; good knowledge of modern gauging methods; experience in production methods throughout a large modern engineering works; sound knowledge of works stores procedure; responsible administrative experience in large engineering works, but locomotive and carriage and wagon experience not essential; age 30 to 40 years.

(B) THREE ASSISTANT WORKS MANAGERS and (C) FOUR PRODUCTION ENGINEERS (Junior Scale). Qualifications, sound knowledge of modern production methods with special training in machine shop practice; good designer of jigs and tool and fixtures and able to make tool lay-outs; sound knowledge of planning and rate fixing and capable of laying out detailed manufacturing operations; competent to supervise demonstrations of operations on all classes of machine tools; good knowledge of inspection methods and gauging system; should have held responsible position in a large engineering works; locomotive or carriage and wagon experience not essential; age 25 to 35 years.

The appointments will be made on agreement for three years in the first instance, and initial pay within the prescribed scales will be determined with reference to age and qualifications.

Forms of application and further particulars should be obtained from the SECRETARY TO THE HIGH COMMISSIONER FOR INDIA, 42, Grosvenor-gardens, London, S.W. 1. Last date for receipt of applications 18th December, 1926. 4061

PUBLIC NOTICES

Draughtsman Required by the GOVERNMENT of the GOLD COAST for the PUBLIC WORKS DEPARTMENT for two tours of 12 to 18 months' service, with possible extension. Salary £480 a year, rising to £800 a year. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, aged 25 to 30, must be neat and accurate draughtsmen and have passed the Intermediate Examination of the R.I.B.A.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/15013. 4127

Section Engineers (2) Required for the Construction Branch of the FEDERATED MALAY STATES RAILWAYS for two years' service, with possible extension. Salary 400 dollars a month, rising to 800 dollars a month by annual increments of 25 dollars a month, plus a temporary allowance of 10 per cent. to bachelors and 20 per cent. for married men. The exchange value of the dollar in sterling is at present fixed by the Government at 2s. 4d., but its purchasing power in Malaya is at present considerably less than that of 2s. 4d. in this country. No income tax is imposed by the Government of the Federated Malay States at present. Free passages provided. Bonus of three months' salary on satisfactory termination of agreement. Candidates, preferably single, aged 25-38, must be fully qualified Railway Civil Engineers who have received good training and experience on European, American or Colonial Railways. Members or Associate Members of the Institution of Civil Engineers preferred.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/14804. 4117

Hillingdon Cemetery Joint COMMITTEE.

The Committee invite TENDERS for the DRAINAGE and LAYING OUT of ADDITIONAL CEMETERY of some 6 acres adjoining their present Cemetery, Hillingdon, Middlesex.

Bill of quantities and form of Tender may be obtained and plans and specification inspected at the offices of the Committee's Surveyor, Mr. William L. Eves, F.R.I.B.A., F.S.I., 54, High-street, Uxbridge, Middlesex, upon payment of Two Guineas, to be refunded upon receipt of a bona fide Tender.

The Committee cannot bind itself to accept any Tender.

Sealed Tenders, endorsed "Tender, Hillingdon Cemetery," to be delivered to the undersigned not later than Wednesday, the 15th day of December, 1926.

W. O. LOVIBOND,
Clerk and Registrar.

Offices : 1, Vine-street, Uxbridge, Middlesex.
22nd November, 1926. 4044

PUBLIC NOTICES

Barking Urban District Council. PUBLIC SWIMMING BATHS.
TENDERS FOR FILTRATION PLANT, HEATING APPARATUS, &c.

The above Council invites TENDERS for the PLANT and BUILDING in connection with the INSTALLATION and ERECTION at the Public Baths, East-street, Barking, of :—

(a) WATER FILTRATION and AERATION PLANT.
(b) HEATING APPARATUS for Baths Concert Hall and Slipper Bath Water.
(c) BUILDING to House above Plant.

Full particulars and form of Tender can be obtained upon application to Mr. R. A. Lay, Assoc. M. Inst. C.E., Engineer and Surveyor to the Council, Public Offices, East-street, Barking.

Tenders are to be forwarded in the special envelope provided for the purpose, so as to reach the undersigned not later than 7 p.m. on Tuesday, the 21st December, 1926.

The Council does not bind itself to accept the lowest or any Tender.

By Order,
H. HARGREAVES,
Clerk to the Council.

Public Offices, Barking.
1st December, 1926. 4109

Keighley Corporation. WATERWORKS DEPARTMENT.

FOR SALE, REES ROTURBO PATENT REVOLVING PRESSURE CHAMBER HIGH-LIFT PUMP, delivering 18,000 G.P.H. against 250ft. head, coupled direct to REES ROTURBO SHUNT-WOUND ENCLOSED VENTILATED VARIABLE-SPEED MOTOR, 56 B.H.P. at 1780 r.p.m., fitted with Starting Panel, all in excellent working order.

Apply, WATERWORKS ENGINEER,
Town Hall, Keighley.
4111

The Assam - Bengal Railway COMPANY, Limited, is prepared to receive TENDERS for :—

5 METRE-GAUGE ENGINE TURNTABLES.

Specifications and Tender forms may be obtained at the offices of the Company, Bishopsgate House, 80, Bishopsgate, E.C. 2. A fee of £1 1s. is charged, which cannot under any circumstances be returned.

Drawings may be had, at the cost of the tenderer, by application to Messrs. Hodges Bennett and Co., Ltd., 78, Queen Victoria-street, E.C. 4.

Tenders must be delivered at the Company's Offices not later than Noon on Thursday, the 16th December, 1926.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
OSWALD I. MILNE,
Secretary.
25th November, 1926. 4097

PUBLIC NOTICES

Crystal Palace School of Practical ENGINEERING.
Founded 1872.
MECHANICAL AND CIVIL ENGINEERING DIVISIONS.

PRESIDENT : J. W. WILSON M.I.C.E., M.I.M.E.
PRINCIPAL : MAURICE WILSON, M.I.C.E.
Assisted by Staff of Lecturers and Instructors.
Thorough, up-to-date Practical and Theoretical Instruction. Course completed in 2 years.
Students admitted at beginning of any term. 3555

City of Bath. ELECTRICITY DEPARTMENT.

OFFERS are INVITED for the following PLANT, which is to be removed to make room for larger units. The plant is in running order and can be inspected by appointment :—

TWO Pollitt and Wigzell CROSS COMPOUND VERTICAL ENGINES, with Corliss valve gear, working pressure 160 lb., each coupled to a self excited E.C.C. Single-phase 300 K.W. GENERATOR, 100 cycles, 2200 volts, 125 r.p.m.

TWO Bellias and Morcom COMPOUND ENGINES, working pressure of 160 lb., each coupled to 250 K.W E.E.C. Compound Wound D.C. GENERATORS, 500 volts, 250 r.p.m.

ONE Dick-Kerr 300 K.V.A. MOTOR GENERATOR, consisting of a D.C. 6-pole Interpole, 440/500 volts, 600 r.p.m. MOTOR, coupled to a 300 K.V.A., 2200-volt, Single-phase, 100-Cycle GENERATOR.

ONE Dick-Kerr 100 K.W. MOTOR GENERATOR, consisting of One 4-pole, 440/490-volt, 600 r.p.m. D.C. MOTOR, coupled to a 100 K.W., 2200-volt, single-phase, 100-cycle GENERATOR.

TWO Babcock and Wilcox 10,000 lb. WATER-TUBE BOILERS fitted with Underfeed "E" type Stokers.

TWO Babcock and Wilcox Hand-fired 5000 lb. WATER-TUBE BOILERS.

J. W. SPARK,
City Electrical Engineer.
4120

Port of Bristol Authority.
GRAIN HANDLING MACHINERY IN CONNECTION WITH THE EXTENSION OF THE ROYAL EDWARD DOCK, AVONMOUTH, AND THE CONSTRUCTION OF TWO GRANARIES; ALSO ADDITIONS TO EXISTING BANDS.

The Docks Committee are prepared to receive TENDERS for the above, which includes New Conveyors, Bands, Motors and Switchgear.

On and after Friday, the 10th day of December, 1926, copies of the specification and contract drawings can be obtained from the undersigned on production of a receipt showing that a deposit of £5 has been paid. ALL CHEQUES MUST BE MADE PAYABLE to the "PORT OF BRISTOL AUTHORITY" and forwarded to the General Manager and Secretary, Docks Office, 19, Queen-square, Bristol. The deposit will be returned to bona fide tenderers after the receipt of the Tender with all the prescribed documents and drawings.

Tenders must be enclosed in a sealed envelope and endorsed "Tender for Grain Handling Machinery," and addressed to the General Manager and Secretary of the Port of Bristol Authority, 19, Queen-square, Bristol, and must be delivered to him, accompanied by all the prescribed documents and drawings, before 10 a.m. on Monday, the 10th day of January, 1927.

The Docks Committee do *not* bind themselves to accept the lowest or any Tender.

THOMAS A. PEACE,
Engineer.

Chief Engineer's Office,
Avonmouth Docks.
3rd December, 1926. 4140

South Indian Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

1. SCREWS, BOLTS, NUTS, &c.
2. INDIA RUBBER PADS and CUSHIONS.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Screws, Bolts, Nuts, &c.," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 17th December, 1926.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 5s. for each copy of each specification.

Copies of the drawings may be obtained at the offices of Messrs. Robert White and Partners, Consulting Engineers to the Company, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.

91, Petty France, S.W. 1.
30th November, 1926. 4132

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PUBLIC NOTICES

County Borough of Belfast.

TO MOTOR MANUFACTURERS.

The Belfast Corporation invite TENDERS for the SUPPLY of TWO PETROL MOTOR SWEEPING MACHINES for Street Cleansing purposes.

Firms tendering will require to submit full particulars of the type of machines which they propose to supply; they must also comply with the Council's Standing Orders relating to wages, hours of labour, &c.

Sealed Tenders, in envelopes marked "Tender for Motor Sweeping Machines," and endorsed with the name and address of the firm tendering, must be lodged in my office not later than Twelve Noon on Monday, 13th December.

R. MEYER,
4094 Town Clerk.

Administrative County of LONDON.

The London County Council invites APPLICATIONS for the APPOINTMENT of ASSISTANT DIVISIONAL OFFICER in the London Fire Brigade. Candidates must be of robust health, strong and active, and their ages must not be less than 25 and not more than 30 years. They must have had a good general education, and must possess a sound knowledge of mechanical engineering. Experience in the control of men is essential.

The commencing salary attached to the position is £400 a year (based on pre-war conditions), with free quarters, uniform, coal, light, and medical attendance. This salary is subject to temporary additions, fluctuating according to the cost of living, the total commencing remuneration at present being £547 9s. 5d. a year. The next revision of the temporary additions will take place not later than 1st March, 1927. As from and including 1st April, 1927, the scale of salary (based on pre-war conditions) will be £400, rising by annual increments of £25 to £550 a year.

Preference will be given, other things being equal, to candidates who have served, or attempted to serve, with H.M. Armed Forces. Candidates who have not so served must be natural-born British subjects.

Forms of application, with particulars, may be obtained from the Clerk of the Council, The County Hall, Westminster Bridge, S.E. 1, and must be returned to him by 31st December, 1926, endorsed "Assistant Divisional Officer, L.F.B." An addressed foolscap envelope, bearing 1½d. stamp, must be sent with the request for form of application.

Canvassing disqualifies.

MONTAGU H. COX,
4134 Clerk of the London County Council.

County Borough of Brighton.

WATERWORKS DEPARTMENT.

APPOINTMENT OF ASSISTANT ENGINEER.

The Council invite APPLICATIONS for the APPOINTMENT of ASSISTANT ENGINEER at a commencing salary of £450, rising to £500 per annum at the end of 12 months.

The appointment will be for a period of six months in the first instance, and will be made permanent, subject to satisfactory service during that time.

Applicants, who should have passed the Associate Membership Examination of the Institution of Civil Engineers, must have considerable experience in the design of modern steam pumping plant, buildings, service reservoirs, &c., as well as the general administrative work of a large waterworks undertaking.

Applications, in the candidates' handwriting, stating age, training, experience and qualifications, together with copies of three recent testimonials, should be forwarded to the undersigned on or before the 20th December, 1926, endorsed "Assistant Engineer, Waterworks Department."

Canvassing, either directly or indirectly, will be a disqualification.

Town Hall, Brighton, JAS. H. ROTHWELL,
18th November, 1926. Town Clerk.
4052

Municipality of Colombo, CEYLON.

APPOINTMENT OF A FIRST GRADE ENGINEER.

The Colombo Municipal Council REQUIRE the SERVICES of a 1st GRADE ENGINEER.

Applicants must have had at least 10 years' practical engineering experience, including experience in Municipal Work and Practical Town Planning, and must have passed the A.M.I.C.E. qualifying examination.

The salary attached to the post is Rs. 12,000 a year, rising by annual increments of Rs. 480 to Rs. 15,000.

The officer appointed must provide himself with and maintain a motor car, for which he will receive an allowance of Rs. 1800 a year.

The selected candidate will be required to enter into an agreement to serve the Council for a period of three years. At the end of three years, if the officer has carried out his duties to the satisfaction of the Council, he will be appointed to the permanent staff, with leave and pension rights according to the Council's regulations.

Medical examination as to fitness for service in the East is required.

Free passage to Colombo, second class by mail steamer or first class by other steamer, will be provided, with half-pay during the voyage.

Application forms and further details can be obtained from the Council's London Agents, Messrs. JOHN POOK and CO., No. 68, Fenchurch-street, London, to whom candidates should forward their applications before December 21st, 1926.

Town Hall, Colombo,
30th October, 1926. 4128

CHIEF ENGINEER FOR PORT OF CHITTAGONG.

The Port Commissioners of Chittagong REQUIRE the SERVICES of a CHIEF ENGINEER, on a three years' agreement, in the first instance; first-class free passage for himself to Chittagong and home again on satisfactory termination of services.

SALARY.—Rupees 1000, rising by annual increments of Rs. 50 to Rs. 1600, if service is extended. PAY to commence from date of sailing.

QUALIFICATIONS.—Candidates must have had previous practical experience on Dock and Harbour Works, and also a knowledge of Reinforced Concrete Design and Construction.

Applicants should forward copies of testimonials, which will not be returned, and also particulars of nationality, education, age, diplomas or degrees, which must be accompanied by a record in chronological order of candidates' training and subsequent experience.

The selected candidate will be required to join as soon as the necessary arrangements can be made.

Application to be made by letter only, not later than 31st December, 1926, to

RENDEL, PALMER and TRITTON,
4095 12-14, Dartmouth-street, Westminster, S.W.1.

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, a Well-educated ASSISTANT ENGINEER for Structural and General Engineering Works under British management in India, preferably University engineering training and A.M.I.C.E.; must be good organiser and have had thorough business and technical training and practical experience. Age 30 to 35.—Address, stating age, qualifications, experience and salary expected, P2537, The Engineer Office. P2537 A

WANTED by Allied Engineering Trade, TECHNICAL and SALES ASSISTANT with shop and drawing-office experience. Applicants single and under thirty preferred.—Address, stating age and qualifications, P2513, The Engineer Office. P2513 A

WANTED for Large Light Engineering Works in Manchester, a highly trained and experienced WORKS MANAGER. Must have held similar position with responsibility for large-scale production and be capable of organising output of new inventions. Only first-class men need apply. Technical College or University Graduate preferred. Age not over 40. Commencing salary £800/1000 per annum.—Address, with copy testimonials, 4143, The Engineer Office. 4143 A

ARNOLD BOOKS

Just Published.

ELECTRIC TRAINS.

By R. F. DICKINSON, B.Sc. A.M. Inst. C.E., A.M.I.E.E., Works Manager, Electric Train Repair Shops, New South Wales Government Railways.

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A practical exposition of the fundamental principles of electric traction, with the devices and apparatus in use and of convenient methods of making the calculations required in train operation.

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SECOND EDITION. xviii + 398 pages, 106 Illustrations. 16s. net.

LONDON EDWARD ARNOLD & CO. 41 & 43, MADDOX ST., W.

SITUATIONS OPEN (continued)

WANTED, WORKS MANAGER for Old-established Locomotive Building Works, conversant with up-to-date methods of construction and works management.—Address, stating age, experience, salary required, &c., 4133, The Engineer Office. 4133 A

BLAST-FURNACE MANAGER, an ASSISTANT, REQUIRED. Must be competent, practical man, used to control of Hematite Blast-furnaces, with a thorough grasp of the process and used to handling men.—Apply, with full particulars as to age, qualifications, experience, and salary required, to SECRETARY, Consett Iron Company, Ltd., Consett, Co. Durham. 4099 A

CHIEF ACCOUNTANT WANTED for Important Works in South-West Lancashire, manufacturing Steel Rods, Wire and Wire Products. Experience of accountancy in large works essential, also experience on the commercial side.—Replies, with full particulars, including salary required, which will be received in strict confidence, to Box Y.Z. 26, c/o Deacon's Advertising Offices, Fenchurch-avenue, London, E.C. 3. 4113 A

ENGINEER REQUIRED, to Act as SERVICE INSPECTOR for Large Firm engaged in the manufacture of Aeroplane Engines. Applicant must be a fully qualified engineer with experience of Aero Engines and capable of representing the firm both at home and abroad. Preference will be given to applicants who hold Air Ministry Ground Engineers' Certificates and have held a commissioned rank in one of the Services.

Address, stating age, experience (in date order), and salary required, 4108, The Engineer Office. 4108 A

ENGINEER (Scotsman Preferred), About 25/28 years age, WANTED as ASSISTANT to Engineering Works Managing Director. Applicants must have had a sound general education at a public school and considerable technical training in mechanical and electrical engineering at a University or good Technical College; also at least FIVE years' practical experience in drawing-office, pattern shop, foundry, machine and fitting shops and test department. Preference will be given to an applicant with experience of Light Pumping Machinery and Steam Engines, but this is less important than that he should have a broad training combined with energy and ability with a view to learning his duties quickly.—Address, stating age, salary, and full details of experience and training, 4110, The Engineer Office. 4110 A

MACHINE TOOL DESIGNER.—An OPENING occurs for a First-class MACHINE TOOL DESIGNER of good education and broad views, who is capable of earning £1000 a year.

Applications will be treated in strict confidence.

Address, P2540, The Engineer Office. P2540 A

PROGRESS MAN WANTED for Switchgear Factory. Real live man with practical experience, capable of following all details through manufacture, despatching orders strictly to date, and dealing with all correspondence.—Write, giving full particulars, age, salary, &c., Box 381, Sells, Fleet-st., E.C. 4. 4102 A

REQUIRED by London Firm Representing Continental Works, REPRESENTATIVE or SUB-AGENT for Midland area for Sale of Continental Steel (Rolling Mill Products). Applicant must have connection in district. Successful man would be treated liberally.—Address, 4144, The Engineer Office. 4144 A

REQUIRED by London Firm Representing Continental Rolling Mills, SALESMAN, with knowledge of Light Rail and Equipment Business. Applicant must have successfully held similar position and have thorough knowledge of business.—Address, 4145, The Engineer Office. 4145 A

WORKS MANAGER.—WM. DIBBEN and SONS, of Southampton, REQUIRE a competent WORKS MANAGER, who has specialised in Heating and Lighting Installations and is a sound organiser. Highest credentials are essential.—Address, 4130, The Engineer Office. 4130 A

WANTED, DRAUGHTSMAN, Experienced in Pumping Machinery, with special knowledge of Turbine and Centrifugal Pumps. State salary required and experience, with names of previous employers (which will be treated in strict confidence).—Address, 3986, The Engineer Office. 3986 A

SITUATIONS OPEN (continued)

THE OCEAN ACCIDENT and GUARANTEE CORPORATION, LIMITED, REQUIRES the SERVICES of an additional CRANE INSPECTOR. Age 24-28. Commencing salary £260. Candidates must have a sound practical training in the manufacture and erection of various types of Power Cranes and be able to make clear and accurately dimensioned sketches. The appointment is to the permanent staff and will be strictly subject to medical examination.—Applications, in own handwriting, giving full particulars, including age and whether married or single, to be addressed to 4100, The Engineer Office. No interviews except by appointment. 4100 A

WANTED for London, Good (Smoke-tube) BOILER DRAUGHTSMAN, able to record and calculate trial results as well as undertake ordinary drawings and stresses.—Address, stating age, experience, and salary required, P2547, The Engineer Office. P2547 A

WANTED for London, MECHANICAL DRAUGHTSMAN, if possible with experience in design and construction of Asphalt and Road Plant. Age 25 to 30.—Address, 4125, The Engineer Office. 4125 A

DRAUGHTSMEN for Ropeways and Cranes. Accustomed to preparing schemes and estimates.—Apply, stating age, experience, wages, when free, CHIEF DRAUGHTSMAN, John M. Henderson and CO., Ltd., King's Works, Aberdeen. 4126 A

GOOD SENIOR DRAUGHTSMEN WANTED for Steam Power Station Lay-out Work. Previous experience preferred.—Write, stating age, training, experience, salary, and date free, to CHIEF DRAUGHTSMAN, English Electric Co., Ltd., Rugby. 4141 A

JUNIOR DRAUGHTSMAN REQUIRED (London district). Experience in Pumping Machinery preferred. State age, salary, and experience.—Address, 4124, The Engineer Office. 4124 A

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For continuation of Small Advertisements see page 3.

A Seven-Day Journal

Electrical Progress in European Countries.

AT an informal meeting recently held at the headquarters of the Institution of Electrical Engineers, Mr. J. F. Shipley opened a discussion on electrical progress in European countries. In his opinion, Switzerland is the country in which electrical progress has been most rapid. At the recent Exhibition at Basle, it was shown that in 1914 less than 60 per cent. of the houses in the chief cities were electrified, while in 1925 the proportion reached 98 per cent., and the average for the whole country was 95 per cent. An extensive programme of railway electrification is now in hand, and in the year 1928 no less than 64 per cent. of the total length of lines will be electrically operated. In Basle one family in ten uses electric water heaters. Turning to Austria, Mr. Shipley remarked that after the war it was vitally important for that country to restrict imports and develop exports. Numerous large water power stations were erected, a big programme of railway electrification was put in hand, and a large amount of electrical energy was exported to Germany. On account of the general poverty and unequal distribution of the population, progress in the agricultural and domestic fields had not been great. Germany's progress, Mr. Shipley explained, had been astounding. That country is now covered with a network of transmission lines, and some of the supply companies transmit power over a distance of 300 miles.

Stabilisation and Trade in Belgium.

THE efforts to stabilise the currency in Belgium have had the immediate effect, which was fully anticipated, of arresting industrial activity, and as it is obvious that a complete commercial reorganisation will have to be carried out in order to ensure a revival of business the Government has created a Director-General of Foreign Trade, whose function it is to provide foreign markets for Belgian manufacturers. The new Director-General, Monsieur Harancourt, arranged a conference recently at which he stated that the situation in Belgium could only be improved by developing exports, for which purpose it was necessary to centralise industry in the way that was being followed in Germany and the United States. Such a centralisation means that by cutting down production costs as much as possible, and securing a complete control of their own market, manufacturers will be in a better position to dispose of their goods at lower prices abroad, but this outcome implies that the home market must absorb sufficient to justify a heavy production, the surplus of which would be available for export. Otherwise, little can be done against the fiscal barriers which are being raised all over Europe. Belgium has recently once again raised her own.

Naval Construction in Japan.

AFTER undergoing considerable modification, the new Japanese naval programme, designed to supplement that of 1922, has now been approved by the Government, and is to be submitted to the Diet during the coming session. It is proposed to spend £26,000,000 on new construction within the next five years, namely, on four cruisers of 10,000 tons, fifteen large destroyers, four submarines, two special service vessels, and three river gunboats. The cruisers are to be replicas of the "Nachi" class, with a speed of 33 knots and an armament of nine 8in. guns on triple mountings. The destroyers were originally designed as flotilla leaders, to be armed with 5·9in. guns, but in the interests of economy the displacement will be kept at 1800 tons and 4·7in. guns be substituted for the heavier weapons. The fifteen new boats are additional to the four that were sanctioned last year. All four submarines will be of large dimensions, not less than 2000 tons. Of the special-service ships, one is understood to be an aircraft carrier and the other a minelayer. The vessels mentioned are to be completed by not later than 1931. Meanwhile a number of units authorised under the 1922 programme have yet to be launched. They include four cruisers, about twenty destroyers and eighteen submarines. The submarine I 2 of this programme, which went afloat at Kobe recently, appears to be the largest underwater craft so far built in Japan. She is stated to be of 2200 tons, with a speed of 25 knots. The armament is given as two 4·7in. guns and a 3in. A.A. gun. An aeroplane is carried on board.

London Transport.

ON Monday, November 29th, the London and Home Counties Traffic Advisory Committee, a body over which Sir Henry Maybury presides, issued two important reports dealing with transport conditions in North-East and East London. The reports are of more than local interest, for in addition to recommending the consideration of electric railway extensions and the electrification of the London and North-Eastern Company's existing "steam" services to the suburbs, the whole problem of London passenger transport is brought under consideration and an important proposal for its solution is advanced. The solution is that the whole of London's traffic facilities, including railways, omnibuses and tramways, should be placed under a common management with a common fund. The scheme was advanced by the Underground Railway group as a means of meeting the financial difficulties which are the stumbling blocks to all railway development in Greater London. The ownership of the existing undertakings would not be disturbed. The Board of Management would be formed from the officials of the undertakings, and would be responsible to an over-riding authority, which would settle questions of policy and exercise general financial control. All the existing forms of transport would be co-ordinated, so that each might perform the work for which it was best adapted and the prevailing uneconomic and wasteful competition would be eliminated. It is held that, given co-ordination, the traffic available in London is sufficient to give a satisfactory return on the large amount of capital already invested in transport undertakings, and also to provide a margin of income which would enable a steady policy of development to be pursued. Whether the suburban services of the four main line railways should be brought within the scheme is a point on which no definite conclusion is expressed in the report. The Committee recommends that a further examination of the scheme should be undertaken without delay, and expresses its willingness to make that examination and report its findings to the Ministry of Transport.

Armstrong, Whitworth's Reorganisation.

LIKE some other large undertakings identified with the manufacture of war material, Sir W. G. Armstrong, Whitworth and Co., Ltd., have encountered difficulties in adapting their works and activities to peace-time conditions. It was officially announced this week that an important step was being taken in connection with the affairs of the company, and that proposals for a scheme of reorganisation would be laid before the shareholders as soon as an advisory committee which was inquiring into the position had completed its labours. The committee referred to acts under the chairmanship of Sir George May, of the Prudential Assurance Company, and includes Mr. A. H. Campbell, chairman of the London Stock Exchange; Mr. Clifford Johnston, of the Mercantile Investment and General Trust Company; Mr. R. P. Sloan, of the Newcastle-upon-Tyne Electric Supply Company; Mr. J. P. Green, of the Refuge Assurance Company; and Mr. J. F. Taylor, vice-chairman of Messrs. Armstrong, Whitworth's. For the year ended December 31st, 1925, the company, after charging £601,661 to debenture stock and loan interest, and crediting £900,000 transferred from general reserve, showed a balance on profit and loss of only £8498, whereas for the previous year there was a net profit of £505,250.

Mr. J. M. Browning.

MR. J. M. BROWNING, the inventor of various quick-firing weapons, who died on Saturday last, November 27th, in Belgium, while on a visit to the National War Factory at Herstal, near Liége, was a gun designer of international repute. He was born at Ogden, Utah, on January 21st, 1855, his father being Jonathan Browning, a gunsmith, who had settled in Ogden. Even at an early age the boy showed marked mechanical genius, and at thirteen he constructed his first gun from scrap materials taken from the workshop of his father. It was in 1879 that Browning first patented his single-shot breech-loading rifle, which later became the property of the Remington Company. After producing a gun and an automatic pistol, he designed a repeating rifle in 1884 and subsequently, in 1890, the Colt machine gun, which was used in the United States Army. The American Army also used his box magazine in the war with Spain. Although not always associated with his name, Mr. Browning designed many types of sporting rifles, including the Winchester and the Stevens, and also the Colt automatic pistol. Curiously enough, the only one of his many inventions which bears his name, the Browning pistol, was made at the Belgian National War Factory near Liége, where Mr. Browning died.

The End of the Coal Dispute.

IT will never be possible to assign a definite date for the end of the great coal dispute of 1926, but if one must be named, Monday, November 29th, will serve as well as another. The end has been in process of realisation for nearly two months, but not until Friday of last week, November 26th, could it be said that officially the dispute was over. On that day the Miners' Federation virtually abandoned further attempts to control the situation nationally. Having refused the Government's proposed terms and having sought in vain to enforce its own ideas on the district associations and local coalowners, it was reduced to authorising the resumption of work as soon as the local settlements had been endorsed by the men. Without the restraint of the central organisation, the districts, with the exception of Yorkshire, Durham and South Wales, speedily reached agreements with the local owners, and on Monday of this week there was a general return to work under the orders of the district associations. On the same day all restrictions on the sale and use of coal and coke for industrial and domestic purposes ceased, only the embargo on the export trade remaining in force. On Tuesday the local organisations in Yorkshire, Durham and South Wales were in a position to announce the acceptance of the district terms offered by the owners, and to order a resumption of work before the end of the week. The terms arranged differ from district to district, and have not been governed in any way by a scheme of national uniformity in certain of their broad principles, as at one time or another it was proposed by the Government and also separately by the Miners' Federation that they should be. The hours of work arranged are either 7½ or 8 per day, or some form of compromise such as that adopted in South Wales, namely, 8 hours on five days and 7 on Saturdays. In general, the agreements have been made to last for a period of three years, although in some instances, as in the Nottingham and Derbyshire area, the period extends to five years, while in others, such as Northumberland, it runs to but two years.

Italian Shipbuilding Developments.

AN important order for five 14-knot motor ships has been recently placed by the Societa di Navigazione San Marco, of Venice, for its Fiume and Smyrna lines. The ships are to be built at Trieste at the Stabilimento Tecnico Triestino Yard, and the engines will be made at Turin by the Fiat Company. The main propelling machinery will be 1600 brake horse-power units, designed for a speed of 150 revolutions per minute for both the three twin-screw and the two single-screw vessels, and electrical auxiliaries are to be fitted. According to the Rome paper *Tribuna*, designs are being prepared for two 45,000-ton liners to be named the Rex and Dux, in which a new system of propulsion is to be employed, making possible a speed of 40 knots. As yet no further details of these ships are forthcoming.

The White Star Line.

THE announcement that the Royal Mail Steam Packet Company will acquire the whole of the share capital of the Oceanic Steam Navigation Company, Ltd.—the White Star Line—from the International Mercantile Marine Company, of New Jersey, as and from January 1st, 1927, is one that has been received with satisfaction alike by British shipowners and shipbuilders. The entire British ownership of this line—although the vessels have always sailed under the British flag—will further enhance the prestige of our merchant fleets, while the long connection of Harland and Wolff, Ltd., with the White Star Line will remain unbroken, since Lord Kylsant is the chairman both of the board of that company and of that of the new owners. In this connection, it is of interest to note that Mr. P. A. S. Franklin, the president of the International Mercantile Marine Company, of New Jersey, has confirmed the report that the White Star Line has just placed an order with Harland and Wolff, Ltd., for a very large liner. It is stated that the price offered by the Royal Mail Steam Packet Company to the International Mercantile Marine Company for the shares of the Oceanic Steam Navigation Company, Ltd., is about £7,000,000, a sum little different from that of the earlier offer of Furness, Withy and Co., Ltd., which has already been referred to in these columns. It is generally understood that the sale of the White Star Line will pave the way for further negotiations between the International Mercantile Marine Company and the United States Shipping Board for the acquisition of American liners, and in this connection it is not unlikely that further negotiations may be resumed with other British interests for the sale of the ships of the Leyland Line and the Atlantic Transport Line.

Oil Tanker Orders.

A WELCOME order for British shipbuilding yards is that which has just been placed by the Anglo-Persian Oil Company, Ltd., of London, for nine new oil tankers. Seven of the new ships will have a deadweight carrying capacity of over 10,000 tons, and the two others will be of 6400 tons. Of the larger ships, three are to be constructed by Palmers' Shipbuilding and Iron Company, Ltd., two by the Caledon Shipbuilding and Engineering Company, Ltd., of Dundee, and one each by Swan, Hunter, Wigham Richardson and Co., Ltd., and the Greenock Dockyard Company, Ltd. All seven ships will be single-screw motor vessels, and will be propelled by Sulzer, Doxford and Burmeister and Wain oil engines. The two smaller vessels, which we understand will be steam-driven, will be built and engined by Sir W. G. Armstrong, Whitworth and Co., Ltd. Other tankers, orders for which have recently been placed, include two for the Anglo-American Oil Company, Ltd., each of 12,500 tons deadweight carrying capacity. One will be built by Workman, Clark and Co., Ltd., of Belfast, with Workman Clark-Sulzer type oil engines, and the other will be constructed by Sir James Laing and Sons, Ltd., of Sunderland, and fitted with Doxford oil engines. The East Coast will also benefit by the two large motor cargo vessels which have recently been placed with Swan, Hunter and Wigham Richardsons, Ltd., by the Shaw, Savill and Albion Company, Ltd., of London, which are to be engined with Wallsend-Sulzer machinery.

Main Line Railway Electrification.

By Sir PHILIP DAWSON, M. Inst. C.E., &c., Consulting Engineer, and
S. PARKER SMITH, D.Sc., M.I.E.E., Professor of Electrical Engineering, Royal Technical College, Glasgow.

No. XV.—U.S.A.: NORTH-EASTERN STATES.*

B.—THE NEW YORK, NEW HAVEN AND HARTFORD RAILROAD.†

1. HISTORICAL: REASONS FOR ELECTRIFICATION.

THE N.Y.N.H.H.R.R. was formed in 1872 by the union of the Hartford and New Haven Railroad and the New York and New Haven Railroad, including the shore line railway between New Haven and New London. These lines are situated in the seaboard states of New York and Connecticut. Later, various other short lines, *e.g.*, those to Providence (Rhode Island) and Boston (Mass.), were added. In 1898 the present system was practically complete and included a route length of over 3000 kiloms. The railway company very early became interested in electrification. The Nantasket Beach branch line between Nantasket Junction and Pemberton, Mass., 14 kiloms. in length, was electrified in 1895, antedating by a few months the celebrated Baltimore tunnel electrification of the Baltimore and Ohio Railroad. The original steam generating plant and much of the overhead trolley wire were in use up to 1920. A third rail as a conductor to supply energy to trains was used in 1896 on an extension of the Nantasket line to E. Weymouth. Further developments elsewhere occurred at the same time with the third-rail system, and continued until 1906, when the third-rail installation in Connecticut was discontinued on account of State legislature.

In 1903 legislation was passed by the New York State compelling the electrification of all railway tracks within the city borders by prohibiting the use of steam traction thereon. As indicated in Figs. 1 *ante* and 5, the main N.Y.N.H.H. line runs to Harlem River, connection into New York city being effected by a branch line from New Rochelle to Woodlawn, and thence by the New York Central Railroad tracks for 19 kiloms. into the Grand Central terminus by a tunnel after crossing the Harlem River. The conditions imposed by its entrance into the city over the N.Y.C. tracks obliged the New Haven Company to arrange for electric haulage. It was decided, however, to adopt a radically different system from that used by the N.Y.C., and to equip the main line for electric operation on the single-phase system to Stamford, Conn., a distance of 34·5 kiloms. from Woodlawn.

The electrified zone is now extended to New Haven, Conn., with the White Plains, New Canaan, and Harlem River branches. It is probably the most comprehensive electrification in the world, all classes of service being operated on the four, five or six-track main line. There is a total of 195 route kilometres and 950 track kilometres. The distance from New York to New Haven is 116 kiloms. The freight yards at Oakpoint, Harlem River and Westchester are served entirely by overhead trolley electric shunting locomotives.

The main line from New Rochelle to the Grand Central terminus is used only for passenger service. The six tracks of the Harlem River line extend south-west from New Rochelle, a distance of about 19 kiloms. This is the main artery of freight traffic, and through passenger traffic between New England, New York City and the South and West, *viâ* Hell Gate Bridge, Brooklyn and the Pennsylvania terminus. Freight is interchanged with other roads by car floats at Oak Point and Harlem River yards, and is also floated to other piers in Greater New York.

The traffic on the N.Y.N.H.H.R.R. is extremely dense. Most of the passenger traffic, at the New York end, is handled at Grand Central terminus, where some 150 trains per day are moved for the company. About 700 freight cars are received daily from the Pennsylvania Railroad, the Long Island Railroad—both by way of the New York Connecting Railroad over Hell Gate Bridge—and from the Lehigh Valley Railroad and the Central Railroad of N.J. by train flat connection.

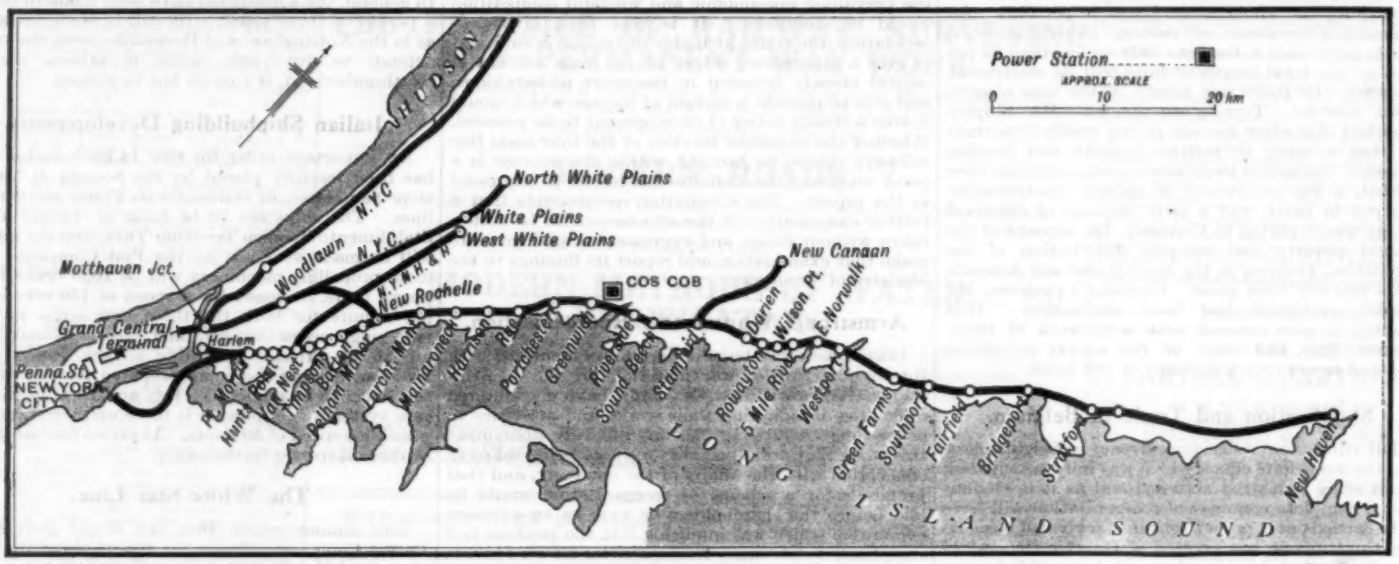


FIG. 5—NEW YORK, NEW HAVEN AND HARTFORD R.R. ELECTRIFIED SECTION

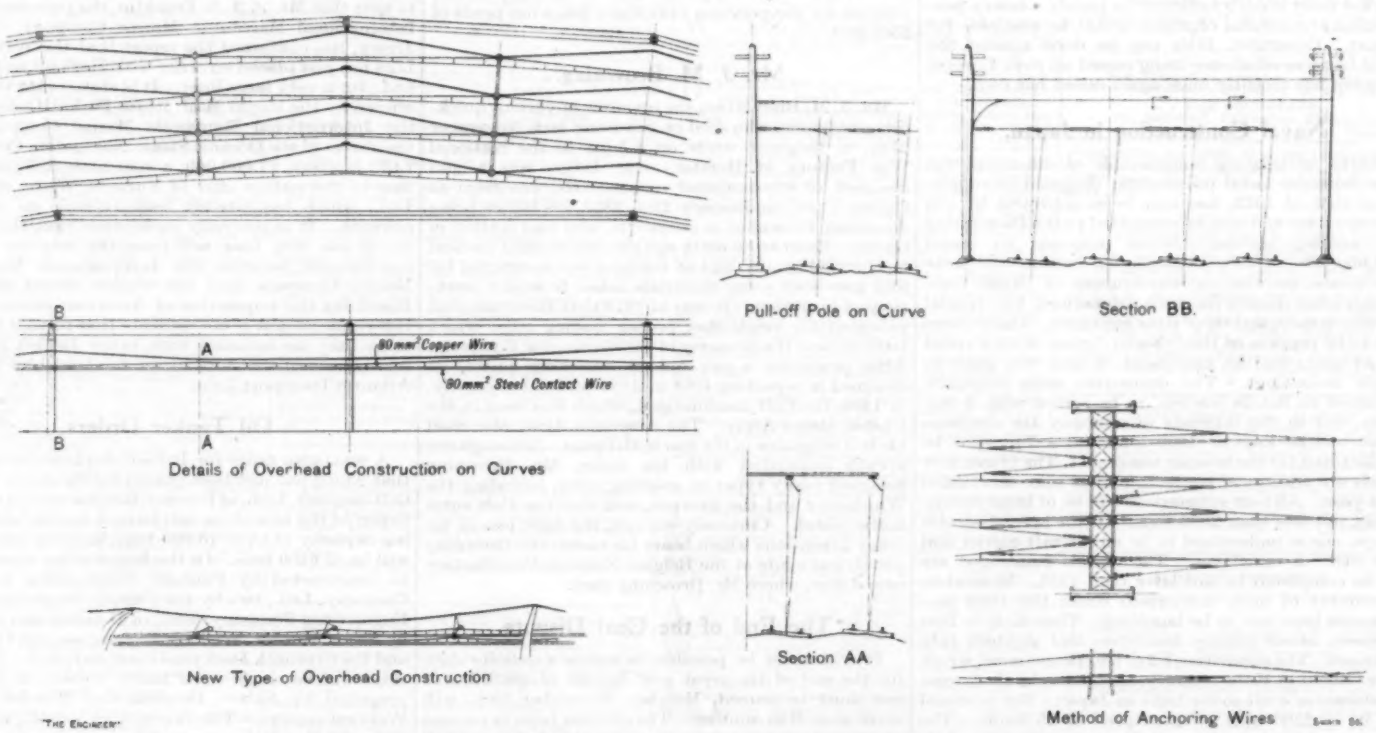


FIG. 6—NEW YORK, NEW HAVEN AND HARTFORD R.R. ELECTRIFICATION—OVERHEAD CONSTRUCTION

2. CHOICE OF SYSTEM.

At the time of the inception of the electrification scheme, the requirements of the system were that it should be suitable for long-distance extension, and would allow of the interchange of traffic with the N.Y.C. tracks, already electrified at 600 volts, direct current, with third rail. The single-phase system, with alternating-current series commutator motors was therefore chosen, since these traction units can

* Nos. I., II. and III. (Switzerland) appeared June 6th, 13th and 20th, 1924; Nos. IV. and IV.A (Scandinavia) appeared January 23rd and February 6th, 1925; Nos. V. and VI. (Germany) appeared June 5th and 12th, 1925; Nos. VII. and VIII. (Austria) appeared August 21st and 28th, 1925; Nos. IX. and X. (France) appeared October 2nd and 23rd, 1925; Nos. XI. and XII. (U.S.A., North-Western States) appeared February 12th and 26th, 1926; No. XIII. (U.S.A., South-Eastern States) appeared March 26th, 1926; and No. XIV. (U.S.A., North-Eastern States) appeared November 26th, 1926.

† General particulars of this and the other lines dealt with in this series of articles are given in Table II. *ante*.

be suitably designed and connected to operate also on direct current.

The frequency of supply had to be decided upon, the choice lying between 15 or 16⅔ cycles, as adopted in Europe, and 25 cycles, as that of certain alternating-current power companies already operating in the district. The latter frequency was adopted, with a voltage of 11,000, as conveniently high to avoid the necessity for too numerous sub-stations.

3. Extent of the Present Electrification.

Fig. 5 gives a map of the N.Y.N.H.H.R.R. electrified zone. The separate route lengths are as follows:

	Kiloms.
Main line, Woodlawn Junction–New Haven (four-track)	102
Harlem River branch (six-track)	18·6
Stamford–New Canaan (one-track)	13·5
Total	134·1

The total of 195 kiloms. already mentioned includes the New York Connecting Railroad, &c.

4. General Description.

(*a*) *Power Supply.*—Power for the electrification is generated at the company's station at Cos Cob, Conn., 8 kiloms. from Stamford. This station is situated near the main line on the bank of the Mianus River, about 1·6 kiloms. from Long Island South. The initial installation included three Parsons turbines directly connected to 3750-kilovolt-ampère—single-phase rating—11,000-volt, 25-cycle generators. The generators were wound for three-phase generation to permit careful study of the conditions was made by engineers of the railway and communication interests, which resulted in the rearrangement of both weak-current and traction circuits, with a view to reducing inductive interference and stabilising the lay-out generally.

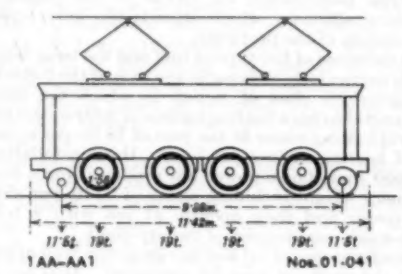
A three-wire system with balancing transformers was evolved. The rails form an earthed neutral between the trolley circuit and feeder circuit, the latter having a pressure of 22,000 volts. "Balancing" auto-transformers are placed at suitable intervals along the track. This had the effect of doubling the transmission pressure in anticipation of the New Haven extension. At Cos Cob power station the generators are connected to quarter points in the windings of six auto-transformers, the middle points of which are earthed, the ends being connected to trolley and feeder circuits respectively. The balancing auto-transformers are placed at sectionalising posts, their terminals being connected to the trolley and feeder circuits, and their central points being earthed. There are twenty-four such balancers. "Milking" or booster transformers are employed on the New Canaan branch, the communication circuits being suitably transposed and provided with drainage coils.

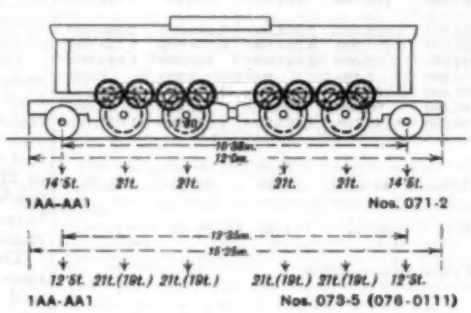
(*c*) *Contact Line.*—Overhead-contact trolley lines of various types are employed, the normal height of the wire above the rail head level being 6·75 m. There are low bridges in many places necessitating a lowering of the contact wire to 5 m. The maximum locomotive speed is 100 kiloms. per hour, so that it has been necessary carefully to grade the trolley wire of 7·5 cm. I-section beams hung transversely across the tracks, and suspension insulators every 45 m. fitted at the quarter-span points. The track or sub-catenaries are 16 mm. diameter steel cables supporting the 80 mm.² copper auxiliary and 80 mm.² bronze contact wires by simple rod hangers.

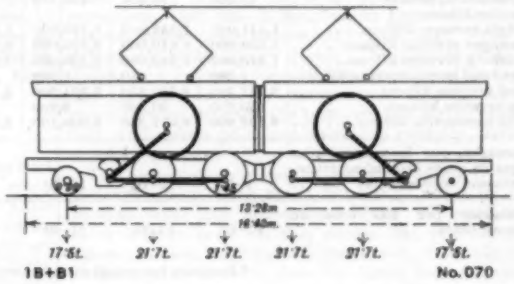
The sidings and goods yards are also provided with 11,000-volt overhead contact wires. The supporting structures are usually lattice towers with cross spans of steel cable. As many as fifteen tracks may be served by a single cross span. The longitudinal arrangement is similar to that of the main lines: simple catenary 90 m. spans are standard, with 10 mm. diameter steel cables, and a 60 mm.² steel or bronze contact wire.

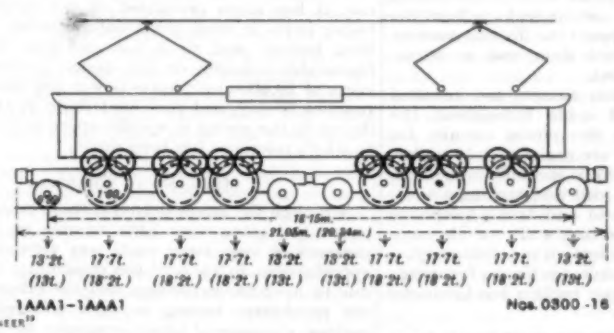
(*d*) *Signal System.*—A 60-cycle track circuit system is employed, supplied from Cos Cob by three induction motor-synchronous generators, the latter developing 450 kilovolt-ampères at 2300 volts and 60 cycles. The signalling load is about 700 kilovolt-ampères, and is transformed up to 11,000 volts for transmission. Both rails form part of the track-circuit, impedance bonds being used for continuity of the traction current return. The signals are mainly motor-driven three-position semaphores, operating in the upper quadrant, and using powerful signal lamps, which are energised continuously but reduced to half power at dusk. The whole signal system forms one of the most extensive single homogeneous schemes yet devised.

(*e*) *Locomotives.*—Outline diagrams of the locomotives are given in Fig. 7 and data in Table III. *ante* A great deal of pioneer work has been done on this









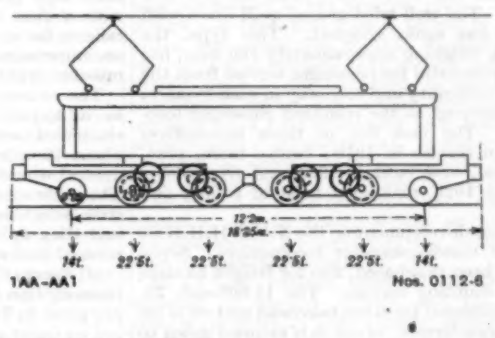


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FIG. 7—NEW YORK, NEW HAVEN AND HARTFORD R.R.—ELECTRIC LOCOMOTIVES

of a supply to tramway and power companies in the vicinity. Subsequently, a further 4160-kilovolt-ampère unit was installed. When the system was extended to New Haven, the Harlem line converted, and the New York, Westchester and Boston Railway completed, the station capacity was again increased. Four 5000-kilovolt-ampère units were installed in 1912, together with new boilers. The transmission pressure was raised to 22,000 volts by six 7200-kilovolt-ampère, single-phase, 11,000/22,000-volt auto-transformers. The annual output of the station is now about 100 million kilowatt-hours.

The equipment at Cos Cob was found insufficient for the load, on account of the heavy suburban traffic terminating at New Rochelle and Port Chester, together with the N.Y.W.B. traffic and the freight loads on the Harlem River branch. The company therefore entered into a contract with the New York Edison Company for the supply of not less than 40 million kilowatt-hours per annum to the New York end of the electric zone. This energy is generated at Sherman Creek station, and is transmitted by underground cable to West Farms switch-house and sub-station. Two 14,000-kilovolt-ampère—single-phase rating—three-phase, 6600-volt, 25-cycle turbo-generators are installed, and a reserve frequency changer set is provided to allow the 60-cycle sets to assist on the traction load when necessary. Subsequently, further increases were made in the Cos Cob plant. The original units of 3750 kilovolt-ampères were replaced in 1923 by a 12,850-kilovolt-ampère, single-phase turbo-generator. Second and third similar units were installed in 1926, making the total installed capacity 62,000 kilovolt-ampères.

(*b*) *Transmission and Transformer Stations.*—Until 1911 a simple direct feeding system was employed. Communication circuit interference was, however, considerable, and damage was caused by short circuits to the circuit breakers and generators. In 1911 a approaches to prevent the pantograph collectors from leaving the wire. A number of arrangements is shown in Fig. 6. On the Woodlawn–Stamford division the supporting structures are substantial lattice towers on concrete foundations, with a normal spacing along the track of 90 m. A feature of this arrangement is the provision of triangular hangers of gradually varying sizes strung along the two 14 mm. diameter suspending catenary cables, serving to connect these and the contact wire into an integral structure. The triangular type of hanger was selected to give lateral stability to the contact wire and to hold it in a correct position above the track centres. This original construction has been modified in most places by the addition of an 80 mm.² grooved bronze contact wire. The triangular hangers are spaced 3 m. apart, and the clips supporting the bronze contact wire are similarly spaced, but arranged between the main hangers. Chord construction is used on curves, the contact wires being held over the track centres in a series of chords by means of pull-offs—see Fig. 6.

At each side of the track, extensions to the towers carry the necessary feeder and signal circuits. All wires, including contact line connections, are anchored to specially heavy anchor bridges every 3 kiloms, approximately.

An experimental catenary construction, involving arched support towers, was erected near Glenbrook. This is of the compound catenary type, the main 32 mm. diameter catenary cable supporting three auxiliary spans. On curves the catenary wire follows the curves of the track instead of hanging in a series of chords. This construction led to the development of the compound catenary structure with cross-beams in the span. This structure has a main span of 90 m. and sub-spans of 45 m. The main catenary cable, of 22 mm.² diameter high tensile stranded steel, is earthed, and does not form part of the trolley circuit, as is usual. It supports the track catenary cables by means road to develop a sound single-phase locomotive design. Difficulties were introduced by the necessity, in many cases, for operating over the N.Y.C. 600-volt direct-current tracks, involving double control gear, motor re-connection, and double current-collecting devices. Further provision had to be made for the multiple-unit operation of locomotives.

The first forty-one passenger locomotives, Nos. 01–041, were supplied in 1906–1908. These were originally of the double-bogie AA—AA type. Four 350 horse-power alternating-current series motors, of the gearless quill-mounted type, were employed. Guiding wheels were later added to the bogie trucks to improve the riding qualities at high speeds, the axle arrangement then becoming 1 AA—AA 1. The weight of these locomotives is 98 tons. They were arranged to be capable of passing from the alternating-current to direct-current tracks without stopping. All of these locomotives are in service at present, and have had an average service of about 2½ million kiloms. (1926).

Increased train weights and extensions demanded heavier locomotives. Four different types were built and tested in 1910–1911. An experimental locomotive with a 1 AA—AA 1 articulated Rushton truck type was constructed with geared quill drive, a single motor to each driving axle. This locomotive is No. 071. Later Nos. 069 and 070 were constructed. The former is equipped with four "twin motors"—eight armatures—with geared quill drive. Each pair of motors, or "twin motor," drives a single gear wheel and driving axle. The quill is connected to the drivers by sets of helical springs. The 070 locomotive has a 1 B + B 1 axle arrangement, comprising a pair of articulated cabs, each carrying a single large 650 horse-power motor with side rod drive to a coupled jack shaft.

The No. 071 locomotive proved to be heavier than was necessary, and a second lighter locomotive of

this type, No. 072, was designed and built in 1911.

In 1912–1913, three passenger and freight, and thirty-six freight locomotives were added to the rolling stock; these are the Nos. 073–075 and 076–0111. All locomotives up to No. 075 inclusive were designed for alternating-current–direct-current operation, while the 076–0111 batch were for alternating-current operation only. These thirty-nine locomotives were equipped with twin motors and geared quill drive as developed on the No. 069 locomotive, combined with many of the mechanical features of the No. 072 locomotive.

In 1916–1917 a complete study of the traffic requirements was made to determine the type of locomotive best suited to the service. The first forty-one passenger locomotives were satisfactory except as to capacity; they had been in service only a few years when the company had begun to replace the light 36-ton wooden coaches with 57-ton steel cars having only a 15 per cent. greater seat-capacity. At the time, double heading was the rule, but it became desirable to have locomotives capable of hauling heavy trains without double heading. The result of the study was the development of the 1 AAA 1—1 AAA 1 locomotives, of the No. 0300 series, from the previous "073" class. The well tried geared-quill drive with twin motors was again adopted. This type, the "0300" class, weighing approximately 160 tons, has proved most successful for passenger service from the standpoint of reliability and economy in maintenance. It is now considered as the standard passenger-locomotive type. The first five of these locomotives were placed in service in 1919; twelve more, practically identical, were built in 1923, and five further locomotives in 1926, making a total of twenty-two of the class.

A more recent development on the N.Y.N.H.H.R.R. is the use of motor-generator locomotives. Seven of these have been purchased, five for freight haulage and two for shunting service. The 11,000-volt 25-cycle energy collected from the overhead system is led to the main transformer, where it is stepped down to 2300 volts and fed into a single-phase synchronous motor. This drives a variable-field direct-current generator connected with normally designed direct-current series motors of the nose-suspension type with "cushion gears." The freight locomotives have a one-hour rating of 1350 horse-power, at 33 kiloms. per hour, whilst the shunting locomotives have a 500 horse-power rating, at 13 kiloms. per hour. Between the pantograph collectors and the main transformer a time-limit automatic circuit breaker is connected; the generator-to-motor circuit is protected by a high-speed breaker. Speed control is effected by adjustment of the generator field. A unity or leading power factor can be obtained on the alternating-current side. This type of locomotive combines the alternating-current distribution—which from many standpoints is superior to direct-current—with the robust and well-standardised direct-current motor.

Some older "switcher" locomotives, delivered in 1911–1912, are listed in Table III *ante*. These, sixteen in number, have proved reliable and economical in maintenance. Six more of a similar type are now being placed in service. A large number of multiple-unit motor coach trains are in operation on suburban services. Maintenance is principally centralised at the Van Nest repair shops.

5. Results of Electrification.

(*a*) *General.*—In considering the results of the electrification on this line it must be remembered that a great amount of pioneer work has fallen to its lot. Experience is costly, and will be reflected in the operating and maintenance costs. It is considered, however, that the wisdom of adopting the single-phase system in the face of the many difficulties has been demonstrated.

(*b*) *Locomotive Maintenance Costs.*—In Table V. herewith the expenditure on locomotive maintenance for the years 1918–1925 is summarised.

(*c*) *Traffic.*—The following figures give an idea of the magnitude of the operations on the electrified zone. The figures are for 1921:—

TABLE VI.—*Traffic Figures for* 1921, *N.Y.N.H.H.R.R.*

Maximum hour peak load, kilowatts	27,500
Train-kilometres per year—	
Passenger	4,000,000
Freight and shunting	934,000
Ton-kilometres per year, including locomotives—	
Passenger	2,192,000,000
Freight and shunting	1,380,000,000
Number of trains per day—	
Passenger: Average	430
Maximum	462
Freight: Average	31
Maximum	41
Schedule speeds, kilometres per hour—	
Passenger: Average	71
Maximum	113
Freight: Average	37
Maximum	65
Maximum weight of train, tons—	
Passenger	770
Freight	3,440

(*d*) *Interference with Communication Circuits.*—With the initial arrangement the interference with communication lines paralleling the railway were sufficiently severe to require a thorough investigation, which resulted in the adoption of the present three-wire system with frequent auto-transformers, with a view to preventing current leakage from the rails as far as economically possible. In this manner an improvement in communication and in transmission conditions was effected.

The railway communication circuits are installed in a 45-pair lead-sheathed cable throughout the electrified zone, paralleling the power circuits for about 72 miles, 56 of which are aerial and 16 underground where the right-of-way is specially congested. The cable contains train and load-despatching circuits with selectors as well as local and trunk telephone and telegraph circuits connecting with outside commercial exchanges. Communication is satisfactory.

(*e*) *Energy Consumption.*—Average figures for energy consumption in watt-hours per trailing ton-kilometre are given in Table VII. below:—

TABLE VII.—*Specific Energy Consumption, N.Y.N.H.H.R.R.*

Service.	Watt-hours per trailing ton-kilometre, average.
Passenger—Express	27–31
Local	50–60
Multiple-unit suburban	40–45
Freight—Fast	14–17
Slow	14–20
Local	27–35

TABLE V.—*Electric Locomotive Maintenance, New York, New Haven, and Hartford R.R.*

	1918.	1919.	1920.	1921.	1922.	1923.	1924.	1925.
Number of electric locomotives	103	108*	108	108	108	108	122	122
Average locomotive weight, tons	95	98	98	98	98	98	103	103
Average weight on drivers, tons	75	76	76	76	76	76	78	78
Locomotive maintenance—								
Repairs, dollars	815,368	1,048,875	1,470,883	1,340,434	1,069,194	1,300,600	1,253,037	1,223,610
Depreciation, dollars	77,470	91,496	148,776	157,314	167,766	169,610	220,545	229,013
Locomotive-kiloms.—								
Freight revenue kiloms.	1,131,000	1,188,000	1,190,000	1,564,000	1,610,000	2,062,000	2,145,000	2,360,000
Passenger revenue kiloms.	5,500,000	6,010,000	6,370,000	6,270,000	6,440,000	6,260,000	6,700,000	7,550,000
Switching revenue kiloms.	1,610,000	1,382,000	1,430,000	1,044,000	1,039,000	1,041,000	955,000	1,020,000
Mixed and special revenue kiloms.	1,300	850	1,300	800	1,100	900	1,300	2,100
Total revenue kiloms.	8,242,300	8,580,850	8,991,300	8,878,800	9,090,100	9,363,900	9,801,300	10,932,100
Non-revenue kiloms.	50,500	90,500	8,800	80,400	98,000	100,000	101,000	99,000
Total locomotive kiloms.	8,292,800	8,671,350	9,000,100	8,959,200	9,188,100	9,463,900	9,902,300	11,031,100
Maintenance per locomotive-kilometre in cents (excluding retirements and depreciation)	9·85	12·10	16·40	14·95	11·64	10·86	12·65	11·10
Maintenance per 100 tons on drivers, cents	13·10	15·95	21·60	19·70	15·30	14·30	16·20	14·20

* Includes two small direct-current shunting locomotives.

Progress of Marine Engineering.*

By Engineer Vice-Admiral Sir ROBERT B. DIXON, K.C.B.

ENGINEER VICE-ADMIRAL SIR HENRY ORAM, one of my distinguished predecessors, in his presidential address to the Institution in 1909, reviewed the progress made in naval engineering to that date and indicated some possibilities then in sight, while holders of the office in later years have also brought to notice current developments and changes in marine engineering practice.

I am told that this subject continues to hold your interest, and I purpose therefore to continue the narrative of marine engineering progress with particular reference to naval practice.

Considerations of Naval Design.

It is desirable to refer in the first place, in order to promote an understanding of the special problems, to the special conditions by which naval design is circumscribed and to show why certain changes which permit advantages in other machinery are denied to the Navy.

To a considerable extent the requirements for naval and commercial machinery run on parallel lines in so far as reliability and durability are the outstanding requirements. These characteristics must be kept well in the foreground. While economy in fuel is a valuable and desirable quality, it has to give way to a varying extent in naval designs to saving in weight, to the need for simplicity, to accommodation in a limited space both in respect of floor space and height, and of the subdivision of the machinery in a number of separate water-tight compartments. These considerations sometimes combine to outweigh the matter of running costs which is necessarily a paramount consideration in commercial work.

A measure of the progress attained in ten years is indicated broadly by the comparison of H.M.S. Lion, referred to in my predecessor's address, and H.M.S. Hood. The comparison marks the transition from coal to oil, from direct-driven turbines to geared turbines, and from the large-tube water-tube boiler to the small-tube water-tube boiler.

The horse-power of Hood, both in the aggregate and unit, is double that of Lion, and is provided for on an equal floor space and on an equal machinery weight. The engine-room complement in Hood is one-half that of the Lion. Thus, in ten years, each ton of machinery weight and each square foot of machinery space were made to do double duty, while each man replaced four who were necessary to operate the earlier design.

The reduction in weight, space and complement is in the main attributable to the change from coal to oil, but the small-tube boiler and the large boiler units possible with this type also contribute to the advance, as does also in respect to space the geared turbine, observing also that the geared design contributes to the attainment of a higher ship speed on the given horse-power by virtue of the improved propulsive efficiency which attends the lower speed of revolution of the propellers.

The influence of the type of fuel and the large boiler units is particularly striking in the case of the torpedo-boat destroyer class of vessel, in which are fitted boiler units having a heating surface of 8000 square feet and evaporating water at the rate of 18 lb. per square foot of heating surface per hour. Here installations of 27,000 shaft horse-power are produced for a total machinery weight including water of 33 lb. per shaft horse-power, and they operate at sea with a total engine-room complement of twenty-eight.

The advantages of oil fuel are generally well appreciated and need not here be recounted. It is not so well realised, however, that in addition to the direct advantages such as saving in weight and man power, in economy and in convenience which attends its use, it has alone permitted of the development of boiler units in sizes quite impracticable with hand-fired boilers, and so it has exercised a secondary favourable reaction on the design problem. Boiler units of 10,000 shaft horse-power are common naval practice to-day, and they contribute in an important degree to the saving in weight, space and complement to which reference has been made.

Mechanical Gearing.

Although the direct-driven turbine designs of lower power had given very little trouble on service, the prospect of very large units was viewed with some apprehension in view of the possibility of distortion due to irregular expansion and the effect thereof on the reliability, having in view the relatively fine turbine clearances, which economy in performance entails. These facts, coupled with consideration for the propeller efficiency, induced the Admiralty to follow with close interest Sir Charles Parsons' early experiments on mechanical gearing in mercantile designs, and to arrange for an early trial of the system. After experience in two torpedo-boat destroyers of the partially geared type, two torpedo-boat destroyers of the 1913 programme were arranged to be fitted with all-geared turbines, and these vessels came on service at the outbreak of war after satisfactory trials. The trials fully confirmed the promise in improvement, showing in comparison with sister vessels an improved speed and an increase in distance steamed per ton of fuel of 14 per cent. at full speed with the boilers forced at lesser rates. An even more striking gain was revealed at cruising speeds where the distance steamed per ton of fuel increased by some 70 per cent., this being due in part to the use of cruising stages to which the all-geared designs lend themselves more readily than in the larger direct-driven designs. The machinery weight was sensibly the same as in the sister vessels referred to, the extra weight entailed by the turbines and gearing being set off by a saving in boiler weight which the improved turbine consumption permits.

Quickened by the greatly increased construction entailed by the war, the application of the geared design to all classes of ships was rapid, and by the end of the war installations aggregating five million shaft horse-power were on service afloat, ranging from the P. boat of 3500 horse-power to the cruisers of 90,000 horse-power and including steam-propelled submarines. The fact that the performance under the severe conditions of warfare was entirely satisfactory and gearing defects were few, is a tribute to the soundness of the principle, especially when it is considered that gear cutting on this large scale is a relatively new art.

The use of mechanical gearing has fulfilled essential purposes in the development of naval machinery. It has permitted a reversion to the propeller efficiencies which were necessarily sacrificed in varying degree

* The Junior Institution of Engineers. Presidential address delivered in London, December 3rd, 1926. Abridged.

on the occasion of the introduction of the turbine, while occasioning no net increase in machinery weight. The case of the torpedo-boat destroyer class may be quoted in which this figure was increased from 40 per cent. in the worst cases with very fast-running direct-driven propellers to about 60 per cent. It has yielded an improvement in fuel economy and particularly so at cruising speeds, thereby the steaming endurance has been sensibly increased.

It has permitted of the considerable augmentation of power per shaft entailed by the higher speeds demanded in large ships while employing turbines of reasonable size; thereby the reliability is improved and the problems arising in the use of increased steam temperatures and pressures have been simplified.

Over and above these advantages, it permits, without otherwise prejudicing the design, of self-contained units of power, observing that in the direct-driven designs for the larger ships the turbines on the respective propeller shafts are in varying degrees interdependent in so far as they are necessarily compounded to ensure the length of steam path necessary to attain the desired efficiency. To this extent the direct-driven designs suffer in respect of vulnerability by comparison with the geared, as in the latter case damage to any one turbine affects only the performance of its own propeller shaft.

Alternative Systems of Power Transmission.

The alternative systems of transmission of power by hydraulic and electrical means have not been favourably regarded in this country. The former system, in the shape of the Fottinger transmission gear, developed in Germany just prior to the war, was not extensively used, but a somewhat similar device has been introduced recently for use in merchant ships in association with geared oil engines, this being, however, a flexible transmission device rather than a means of reducing the engine speed, which also permits of the engine running with the ship at rest.

The electrical transmission system has only been fitted in isolated installations for mercantile work in this country, in association with oil engines in one design, but it has found considerable use in the U.S.A., where it is employed in all battleships of the U.S. Navy completed since the closing years of the war. This important development has been the subject of considerable discussion and its relative merits in comparison with mechanical gearing have been fully ventilated in the technical Press and elsewhere. There is no doubt that the electrical system as fitted in the United States ships is a proved engineering proposition and that it has given satisfactory service under peace conditions. In comparison with mechanically geared installations the design entails increased machinery weight, and under war conditions it is considered likely to be less economical in fuel and exposed to greater risks of breakdown or disablement. On these grounds, and notwithstanding advantages in some directions, the system has been considered on balance to be less suited to our naval purpose than mechanical gearing, observing further that in any case mechanical gearing has been found to be necessary in the lighter classes of war vessel in all the principal navies to meet the more severe restrictions in machinery weight which operate in these designs.

An electrical transmission system in association with heavy oil engines as the source of power has, however, been fitted in H.M.S. Adventure for use at cruising speeds for the purpose of obtaining a large radius of action at low speeds. This plant is separate from the main steam-driven propelling machinery and will not be in use at speeds higher than cruising speeds.

Superheated Steam.

The naval problem in respect of superheat differs in other respects from the commercial or mercantile marine problem. The latter installations may be expected to operate for the greater part of their time at a high proportion of full load and accordingly fuel economy at low outputs is of little importance. The naval vessel, however, steams for the greater proportion of its service at cruising speed, and while economy in fuel at high speed is essential, it is also necessary that good economy shall be realised at cruising speeds in order that fuel may be conserved in a large steaming endurance obtained on a given fuel stowage. Under cruising conditions only a portion of the boiler installation is in use, and on grounds of reduced wear and tear and fuel economy the plant in use is operated at a relatively low output. Accordingly it is necessary that the design of superheater should be such that a reasonable degree of superheat will be attained under these low power boiler working conditions. Thereby the additional weight and complication attending the use of superheaters is used to the greatest advantage.

Separately fired superheaters are out of the question on account of the additional weight and space that would be entailed. The usual designs of superheaters in use at that time provided in general for the increased temperature being given to the steam at the position where the funnel gases left the generator system, and in such designs the superheat attained at low outputs of the boiler is inappreciable. In any case, and especially in the naval designs where the further exploitation of the waste heat in the funnel gases by feed or air heating has hitherto been rendered impracticable by the design restrictions, such a system, while convenient in many respects, is open to objection on fundamental design principles, in that a given weight of material is not used to the best advantage.

On the other hand, the placing of the superheater element in its logical position in the gas circuit is not without its difficulties, and experimental work was necessary to determine how the conflicting requirements, namely, a remunerative degree of superheat at low outputs and a safe and durable design at full outputs could best be met.

It has been found practicable to devise a design in which as much as 70 per cent. of the maximum superheat is realised with the boiler working at one-fifth output. Exhaustive shop trials of boilers of this type providing an evaporation sufficient for 10,000 shaft horse-power have been carried out with satisfactory results and boiler efficiencies of 80 per cent. and 72 per cent. respectively have been obtained when burning fuel at rates of 0·2 lb. and 1·0 lb. of oil fuel per square foot of total heating surface per hour. The boilers referred to are the usual three-drum small-tube type as modified for the application of superheat, which, as already mentioned, are not associated with any devices for tapping the waste heat in the funnel gases after leaving the generator system. Some difficulties, not altogether unanticipated, have arisen in regard to the materials employed for the superheater supports and fittings external to the pressure system, but they have been surmounted by the employment of the special heat-resisting materials which, thanks to the efforts of the metallurgists, are now available or in course of development to meet the many increased requirements to hand or in sight for material possessing improved qualities in respect of maintaining their rigidity under high temperature conditions.

Water-tube Boilers.

The commercial demand for larger boiler units and for increased output, which considerations are combining to effect an increasing use of the water-tube boiler, both on shore and afloat, suggests that some observations on naval experience with such boilers may be worth putting on record. It is now over thirty years ago that the use of the water-tube boiler became general for all classes of warships. Many types have been used in the interim, as is generally known, but in recent years the three-drum type with small tubes of from 1¼in. to 1¾in. external diameter has been exclusively employed, this type being best suited to meet the needs for the relatively large boiler units and reduced machinery weights entailed by modern warship developments.

It need hardly be said that the quality of the tubes is a matter of first importance, and considerable attention has accordingly been given to the processes of manufacture to ensure the desired finish and quality of the seamless steel tubes used for naval water-tube boilers. At one time foreign steels were considered necessary by the manufacturers to produce tubes to meet the Admiralty requirements and tests, but it is gratifying to record that during recent years the desired results have been obtained from British produced steel.

The specification provides for seamless tubes to be finished by a cold drawing process to ensure a smooth surface inside and outside, and importance is attached to the observance of this condition from the aspect of the improved durability of the tubes which experience shows is thereby attained. Importance, too, is attached to the annealing of the tubes after the drawing process and also after any work involving bending during the boiler shop processes.

The mechanical tests, which include tensile, temper, flattening, bell-mouthing and expanding tests, are carried out at the tube makers' works before acceptance. After receipt at the boilermakers' works the tubes are electro-zinced externally, and this process affords a means of ensuring entire freedom from surface defects as well as a protection against corrosion during the erection of the plant. Finally, each tube is water tested internally to a pressure of 2500 lb. per square inch.

These tests, which are not, of course, all carried out in the case of each individual tube, a parcel test meeting the case in several instances, have proved to be necessary to ensure against any failure on service from the purely material aspect. It is to be observed that in fitting in place in the tube plate each tube is subjected to the rolling and bell-mouthing process, and this affords a useful check on the suitability of every tube in respect of structure and ductility.

Given pure feed and proper use of the feed-heating appliances, the life of boiler tubes of the small-tube water-tube boiler, which range in thickness from ·104in. to ·128in., is found to average about ten years under peace-time conditions.

It is the practice to carry out periodical drill and wear and waste tests, the interval between which is reduced as the age of the boiler increases. Sample tubes are cut out and split for examination and gauging, and by these means the useful life of the boiler tubes can be predicted very closely.

Apart from occasional cases of tube distortion, which are always found to be due to improper operation, *e.g.*, shortage of feed water or the presence of oil, the need for tube renewal arises in general from local thinning due to internal corrosion. In isolated cases the tubes have been found to develop circumferential grooving in the way of bends, and while the cause of this defect is still somewhat obscure the evidence tends to show that defects of this type are initiated by improper processes during manufacture and are avoidable.

Cases of external corrosion of tubes on occasion give rise to the need for partial re-tubing. The action arises from damp soot being allowed to accumulate in certain parts of the tube nest, but, given adequate and convenient means for removing such deposits and proper supervision, defects of this nature need not arise. Importance is attached in connection with the tube life to the provision in the design of means of free expansion for the pressure parts when exposed to heat and to the frequent close supervision and proper maintenance of these fittings on service.

The life given above is based upon the experience with ships now on service. In vessels under construction, however, the introduction of the closed feed circuit and of high temperature feed heaters, together with the improved immunity from condenser tube corrosion, which are promised by the wider knowledge of the underlying causes and by the more resistant condenser tube materials now becoming available, is likely to increase considerably the life, and, apart from casualties, which have to be reckoned with in any service, it is not unreasonable to expect in future a life of generator tubes not less than that of the ship herself.

As regards the other pressure parts of the water-tube boiler, it may be said, with one important exception, that the difficulties in maintenance and upkeep have been appreciably less than with the cylindrical boiler earlier fitted. This follows from the simple and uniform form of the drums and receivers and the uniformity of temperature throughout the system which attends the positive and active circulation, and, given good workmanship initially, leakage of joints is practically non-existent.

The exception referred to is the so-called D water pockets, which were fitted for many years in connection with the three-drum type of small-tube water-tube boiler. In this design the relative configuration of a thick tube plate and a relatively thin wrapper plate is such that the stress induced under changes of internal pressure and temperature is concentrated in the neighbourhood of the junction and may lead, in the course of time, to cracking and ultimate failure of the wrapper plate. Although the design had been fitted for a period of over twenty years, the possibility of this weakness leading to serious lack of strength only became apparent immediately prior to the war, and its development was accelerated under the severe running conditions imposed by a long continued war, leading to some anxiety during the war period. It was found possible, however, as experience was accumulated, to predict very closely the life of a defective pocket by close examination of cores trepanned from the plate under suspicion, and by timely repairs and reinforcement the availability for service of the vessels concerned were not unduly affected.

In all later designs, however, the D pocket was replaced by circular pockets, and this is now the general practice. The change entails additional weight, both in the form of metal and water content, but this addition must be accepted in the interests of durability.

The weight of the brickwork lining of an oil-fired boiler furnace constitutes a not unappreciable proportion of the total boiler weight, and efforts are being continually directed to secure lighter bricks, consistent with maintaining the required standard of durability in resisting the severe temperature conditions on service and of robustness to withstand transport and handling. Satisfactory bricks are at present available which meet the requirements on a weight of 126 lb. per cubic foot. To ensure satisfactory deliveries it is the practice to subject sample bricks to a series of tests, including dropping tests and heating tests. The dropping tests are carried out with the brick in the condition as received from the maker and also after the brick has been subjected to heating tests. The heating tests consist in exposing the brick for several hours to successive temperatures of 2500 deg., 2700 deg., and 2800 deg. Fah. in an oil-fired furnace, the furnace being allowed to cool down between such successive heating. During these tests the bricks are kept under continual observation, special attention being given to its qualities to resist flaking, cracking, fusing, glazing or distortion. Finally, a sample brick in a consignment may be subjected to a fusing test in which it is subjected in an oil-fired crucible to a rapid increase of temperature to 3000 deg. Fah.

It is found that, apart from the quality of the bricks, the efficiency of the somewhat extensive walls required in the high-power boiler units is dependent in no small degree on the design of the boiler casings, and close attention is required at the design stage to ensure on the one hand a sufficiently rigid structure to carry the weight of the bricks, and on the other hand the necessary flexibility to take care of the high temperature changes which arise on service. It is the practice positively to secure all bricks, other than those on horizontal floors, by bolts, and care is necessary to assure that the bolt head is adequately pro-

tected from the fire, having in view the excessive wear and tear of the brick faces which can occur in the presence of molten metal.

The long naval experience indicates that, given proper design—including, above all, adequate provision for circulation within the boiler—and intelligent maintenance and operation, the water-tube boiler is a reliable and economical steam producer. As regards operation, the purity of the feed exercises an important influence on the durability, and greater care is necessary therefore to avoid the ingress of salt to the feed system through the condensers, evaporators or other fittings, and also, as in other types of boilers, to ensure that the feed system is kept free from oil.

Given the proper operating conditions, the pressure parts are practically free from maintenance charges within the tube life given and the repairs are practically limited to those necessary to maintain the efficiency of the brickwork lining and furnace fittings which, owing to the high furnace temperatures, require regular attention and timely repair as the need arises.

Auxiliary Machinery.

Notwithstanding the somewhat extravagant type of steam auxiliary sometimes entailed by the considerations of saving in weight and space, the net fuel consumption on account of auxiliary engines has been kept within reasonable bounds by the further use of the exhaust steam in the main turbines and feed heaters and as primary steam in the evaporators. On the whole, therefore, the fuel consumptions per unit of power for auxiliaries has not been so far removed from that for the main engines as a consideration of the relative steam consumptions alone would suggest. The ideal arrangement would provide for all the power auxiliaries being driven by, or from power supplied by, the economical main engines. While such an arrangement can be pursued conveniently to some extent in power plant practice, it is hardly possible to press this very far in naval practice owing to the scattered disposition of the auxiliaries and the widely varying requirements. There is, too, the question of feed heating; the use of the regenerative feed heating system is not practicable, mainly owing to the complication entailed by the provision required to make proper use of it at all rates of power of the main engines. Feed heating is essential under all conditions of working, both for economy and for durability, and this can in the special circumstances be most economically attained by continuing the use of steam in the case of certain auxiliaries and employing their exhaust steam for feed heating.

The use of higher steam temperatures is likely to lead to the decreasing use of the steam reciprocating engine, in so far as the internal lubrication required leads to the necessity of greater precautions in filtering the feed and to the possibility of greater risk of damage in the highly forced boilers which are liable to damage unless the feed is free from grease or oil. Thus the tendency is to employ turbine-driven auxiliaries in the cases where they are to be driven by steam, except in the case of the standby auxiliaries, which may be electrically driven. In general, the electrically driven auxiliary entails rather greater weight and space. In comparison with the slow-running reciprocating engine the fast-running motor-driven auxiliary is, of course, lighter, but, when allowance is made for the extra provision which has to be made in the form of electric generating power to provide the current, the net result is as stated. The concomitant advantages, however, which include the improved economy referred to, freedom from vibration—an important consideration in warships, where the delicate apparatus necessary to ensure the full use of the fighting appliances have to be safeguarded in this respect—and the absence of steam pipes to outlying spaces make the change on the whole a profitable one.

Oil Engines.

Considerable progress has been attained during the period under review in the application of the heavy oil engine for use in marine propulsion. Its suitability for the slower types of mercantile vessels in which steam held, a few years back, indisputable sway has been established definitely, and for such designs the balance of advantage as between oil engines and steam appears now to be determined by financial considerations rather than on purely technical grounds, keeping in view the intended service and itinerary of the ship. This rate of progress affords, I think, a remarkable testimony to the skill and ingenuity of the workers concerned in the development who have faced and overcome great difficulties.

In its application to faster designs entailing more powerful engines the issue is not so clear cut, and the technical issue of the development of higher powers in a single cylinder enters into the question as well as the question of first cost. These two aspects are closely related one to another and to the problem as it presents itself to the naval designer; that is, the improvement of the power/engine-weight ratio, which is at present, after making due allowance for the improvement in fuel consumption, much inferior to the oil-fired boiler—steam turbine combination.

The further prospects of the oil engine are viewed with considerable enthusiasm in many quarters, but I believe that this optimism is not entirely shared by those in close touch with the technical problems.

In considering the matter of its wider and general application in large units of power in other directions, as, for example, electric power generation or marine propulsion, regard must also be paid to the progress of steam plants. Impelled by the commercial necessity for cheap power and possibly spurred by the high standard in fuel economy set up by the heavy oil engine, the fuel economy of the steam plant has made very great advances in recent years, and in this respect its performance is converging towards that of the oil engine. At the present day a standard of economy represented by the generation of one kilowatt of electrical energy from 1 lb. of coal per hour has been fully demonstrated as commercially attainable in power plants of any output, however large, within the range of modern requirements. That standard, translated to its equivalent marine basis, corresponds to the consumption of a little more than half a pound of fuel oil per shaft horse-power per hour and is susceptible of some further improvement by the use of higher steam pressures. Further, there is promise of sensible improvement if the use of some binary fluid system is found to be commercially practicable.

Admittedly, the complications attending the realisation of economies of this order are considerable and greatly in excess of that of the steam plants hitherto used and on which the reputation of the steam plant for flexibility, durability and reliability of operation has been established. On the grounds of complication, and possibly also for reasons of weight, space and/or first cost, the complete application of the steam developments to marine use does not present itself at present as being a practicable or prudent course. Yet considerable use may nevertheless be made of them, and there is no reason why, as confidence in the advanced types is gained, a marked advance in fuel economy beyond that at present obtained should not be realised in steam plants afloat.

Turning again to the oil engine, there is no question that in respect of fuel economy it has promised and attained a standard considerably in excess of that given by contemporary steam plants; but it appears that some of the disabilities from which it suffers in an increasing degree as its size and power output are increased may possibly be somewhat obscured by this outstanding advantage. I have referred in passing to the problems attending its further development as regards higher unit powers and cheaper and lighter manufacture, and without attempting to cover the whole ground I would invite your close attention to certain of them from the designer's point of view. In comparison with a prime mover, such as a steam turbine, the design of a heavy oil engine presents much greater difficulties. The steady uniform stresses and temperatures in the structural members of a steam plant in operation are replaced by rapidly fluctuating stresses and temperatures. The mechanical stresses to which the material is exposed are, at certain parts of the cycle, out of all proportion to the mean load transmitted, and these stresses are in the case of certain components augmented by heat stresses arising from temperature variations, the higher temperatures being, moreover, of such an order as to prejudice the resistance of the material to meet these stresses. The rubbing parts within the cylinder, on whose efficiency depends the efficiency of the cycle, are exposed to very high temperatures at which lubrication, in the ordinarily understood sense of the word, becomes doubtful. The combustion problem, which embraces the design of the exact mechanism required to give precision in point of time and quantity for the fuel injection, no less than the complete devices to provide for the pulverisation and dissemination of the liquid fuel in close association with its air quantum throughout the combustion chamber, on which its complete combustion in an exceedingly short space of time depends, becomes evidently of greater complexity as size and speed of operation advance.

All the difficulties mentioned increase in varying degrees as the engine power is increased, whether the advance be attained by increase of size, revolutions or increased mean pressure or by combination thereof, and in the face of them the rate of progress towards the production of dependable units of large power and lighter and cheaper engines appears likely to be slow. Indications, moreover, point to a stage in the development of the larger oil engine being reached, when the auxiliary power required to supply the air for combustion will assume such proportions that the high efficiency of the cycle will be discounted appreciably, and, while means may finally be developed for countering this falling-off by retrieving some of the energy now wasted in the exhaust gases, any appliances of that type will increase the first cost and complication to an appreciable extent.

Conclusions.

I have endeavoured in my remarks to convey some idea of the progress attained, and, without venturing to prophesy as to the expectations for the future, to indicate some of the problems that have to be faced in seeking further progress. Actually, as may be inferred from my earlier remarks, the same basic problems really arise whether the developments are intended for naval or commercial work. In short, what is required, while maintaining a proper standard of reliability, is improved fuel economy and improved durability, and that these improvements shall be realised on a lesser machinery weight and on lesser first cost. The designer's underlying aim is accordingly much the same in either case, and, expressed in a few words, is the application of the material and of the human effort employed in the construction of the machine to the fullest advantage.

Nature is chary of disclosing her secrets, and it is evident that each further step will lead to problems of still greater complexity, and, judged by past standards, out of all proportion to the degree of advance contemplated. Hence it follows that the stages of development in future will be more strongly marked by the need for close specialisation, and the net of the designer must be cast even wider to gather for his needs the specialist work of investigators outside the immediate sphere of the practical engineer.

While acknowledging, therefore, with gratitude the debt we, as engineers, owe to the mathematician, physicist, chemist, metallurgist and kindred scientific workers, and to the numerous specialist workers in the wide field of modern engineering practice for the advances which their work has alone permitted us to make, I suggest we should keep well in mind the definition of the term gratitude in the more subtle sense, namely, a lively anticipation of future favours which the growing complexity of our art will need to be conferred on us if progress is to be maintained.

In conclusion, I desire to emphasise the necessity for co-operation and co-ordination of effort, not only in the organisation of each individual engineering concern, but in the industry as a whole, in order that satisfactory progress may continue. Much has been done in this direction in recent years by the engineering institutions and other bodies, which stand essentially for united effort and the wider dissemination of information, but much remains to be done to avoid the quite unnecessary duplication of effort and overlapping of research work which exists to-day. In particular, the pooling of technical data and experiences of individual commercial undertakings to a much greater extent than in the past is greatly to be commended, and if this can be attained in an increasing degree it can hardly fail to lead to speedier and more certain progress in the elucidation of the increasingly difficult problems with which we are confronted.

Models and Analogies for Demonstrating Electrical Principles.

No. XVII.*

Continuing the description of Mr. S. B. Griscom's method of dealing with transmission stability problems by means of mechanical devices, Fig. 140 is a single-line diagram of a transmission system connected into the distribution system supplying a metropolitan district. The hydro-electric station at A transmits its entire output over a two-circuit transmission line sectionalised at the mid-point. Synchronous condenser sub-stations are situated at the mid-point B and the receiver end of the line at C, and are regulated to maintain constant voltages on the high-tension sides of their transformers. Step-down transformers connected to the high-tension bus bar at C feed the power in to lower voltage lines which connect to the principal distribution point F. The generators of the local system, together with additional synchronous

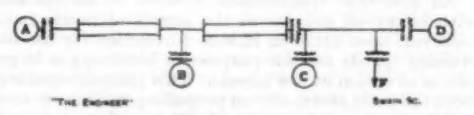


FIG. 140—TRANSMISSION SYSTEM

condensers, also tie in at this point to supply the power taken by the load that is assumed to be concentrated there. All losses and charging currents are neglected. This hypothetical case, while differing considerably in details from operating systems, may be taken as having the same general performance as an actual system having a similar purpose. The diagrams for this system are drawn to scale, hence the physical, dimensions of the assumed case may be of interest, and are given below :—

Generators at A 250,000 kilovolt-ampères, 20 per cent. reactance.

Transformers at A, 250,000 kilovolt-ampères, 10 per cent. reactance.

Condensers at B and C, 90,000 kilovolt-ampères, 20 per cent. reactance.

Transformers at B and C, 90,000 kilovolt-ampères, 10 per cent. reactance.

Generators and condensers at D, 300,000 kilovolt-ampères.

Transmission lines, 220 kilovolts, 150 miles per section.

Reactance from receiver end of transmission system to load centre, 50 per cent. on transmitted kilovolt-ampères.

Reactance of local generators D and distributing lines to load centre, 25 per cent. on generated kilovolt-ampères.

Initial Loading.—

225,000 kilowatts transmitted over transmission lines.

* No. XVI. appeared November 26th.

200,000 kilowatts generated by local machines.
425,000 kilowatts total load at 85 per cent. power factor.
220,000 volts at all terminal points.

It will be observed from the previous sketches that the arms and sliding blocks used to represent the various terminal voltages are unessential to the use of the mechanical device, being shown merely for the purpose of indicating these points. Owing to the number of machines in the case now considered, these arms will be omitted, as well as the fly-wheels simulating inertia of the machines. The springs are shown as elastic bands to simplify the appearance of the sketches.

With the assumed initial conditions given above, the vector diagrams of each of the elements of the system may be constructed and pieced together as shown in Fig. 141, the current vectors being omitted since they are unnecessary. This figure may be considered as the voltage vector diagram of the whole system, with the voltage at the load centre as reference, or as a mechanical model that automatically adjusts itself to the outline of the vector diagram.

Starting at the point D_t the voltage at the load centre, the vector F_L represents the total current drawn from the system, and the product of the vectors O D and $F_L \cos\theta$ gives the total true power of the load. The vector D_tD_o is the total drop in the generators at D and their connecting circuits, and when added to O D_t gives the internal voltage of the local generators O D_o. The portion of the total load current supplied by the local generators may be obtained by dividing the voltage vector D_tD_o by the reactance. For the present analysis, the internal voltages of all

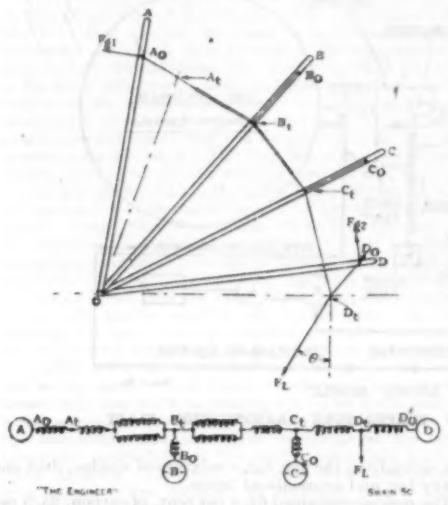


FIG. 141—VECTOR DIAGRAM AND TRANSMISSION SYSTEM

synchronous machines will be assumed to remain constant, hence the point D_o is shown as permanently fastened to the arm D at a fixed distance from the centre O. The point D_t, as well as all others not directly fastened to one of the arms, is subject to variations in value and phase position, as determined by the conditions existing at other parts of the system, as will be shown later. In a similar manner, the position and magnitudes of all other portions of the diagram may be determined, so that the pull of any one elastic band is exactly balanced by the sum of the pulls of the other bands connected to the same point. Likewise, the external moments on the arms A and D, due to the forces F_{g1} and F_{g2}, corresponding to the mechanical inputs to the machines, just balance the torques developed by the elastic bands attached to them. Fig. 141, then, is a diagram of a mechanical system, the forces of which are in equilibrium and the outline of which duplicates the appearance of the voltage vector diagram of the system.

It is evident that no matter what kind of a change is made in the circuit connections, or in the position of the members, the mechanical device will always maintain an equilibrium of tension on the various bands, and, if a small amount of damping is introduced, will finally attain a new position of static equilibrium of the arms, provided such a condition is physically possible. On account of the inertia of the arms, the first effect of such a circuit change is a readjustment of the position of the elastic bands, but since such a readjustment upsets the balance of the torque on the arms, the latter will oscillate in position, eventually coming to rest at a position where all forces are balanced. With properly proportioned bands and inertia, the mechanical device will, at each instant, be arranged so that its outline duplicates the vector diagram of the actual power system at that instant.

A recent paper* has shown how the principal effects of a single-phase fault to earth on a three-phase earthed neutral power system may be duplicated accurately by a symmetrical impedance connected at the point of the fault. On the system considered, and with an earth of zero resistance, this impedance will be reactive only, and, as explained previously, may be represented by a spring of suitable strength attached to the line at the point of the fault and to the pivot. Fig. 142 is drawn to show the effect of such a fault on a power system. The lines of this diagram show the positive sequence voltages at all parts of the network.† Fig. 142 shows the conditions existent in the system at the instant the short circuit occurs. The elastic bands are balanced against each other; hence they show the voltages

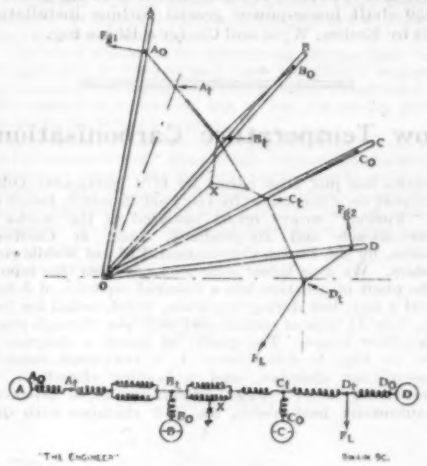


FIG. 142—DIAGRAM SHOWING THE EFFECT OF A FAULT

correctly, but an inspection of the bands showing voltage drops will indicate that their tensions are at more acute angles with respect to the arms to which they are attached, and in some cases are less in magnitude, so that the torque on the arms is less than it was originally. The forces on the arms are therefore unbalanced and the arms will tend to seek new positions. Although the resultant tendency can be approximately traced, no attempt will be made to do so here, except to point out that the arms A and D tend to drift apart in an attempt to restore the original torques with the lowered voltages.

At some later instant, the action of relays will trip out the faulty section of line. A second transient will then be set up in which the system attempts to recover itself so as to transmit the original power at the original voltage. Ordinarily, the voltage regulators would be of considerable assistance in accomplishing this, but in order to simplify the discussion, the generated voltages have been assumed constant. The final position of the vectors would be as illustrated by Fig. 143, assuming that 10 per cent. of the total load is dropped and the power factor increases to 90 per cent. owing to the lowered voltage, and provided the overswing phenomena previously mentioned is neglected. This, of course, is unwarranted, because, in shifting their phase positions, the rotors of the

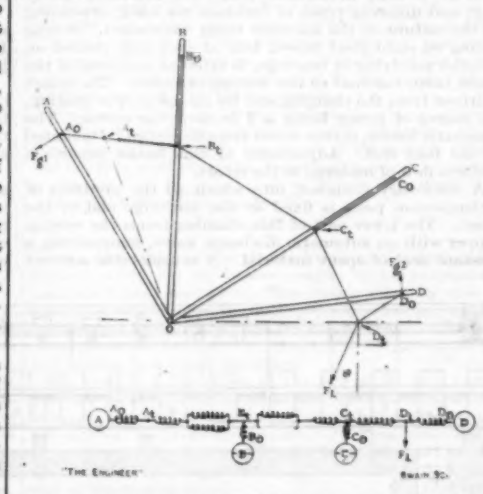


FIG. 143—CONDITIONS AFTER THE REMOVAL OF FAULT

machines accumulate velocities which cause them to swing beyond the critical point. In the case shown, such an overswing would cause the system to pull apart.

The effect produced by a single-phase line-to-line short circuit can be obtained approximately by using a spring twice as strong as that used for the single-phase line-to-neutral fault. For a three-phase short-circuit, the short-circuited point is rigidly joined to the pivot.

The foregoing description of the action of a typical power system, while far from complete, should serve to illustrate how single elements are combined to form a complete system, and how they effect the performance of the system. The function of the synchronous condensers is worthy of particular attention in this connection. Neglecting losses, the current drawn by a synchronous condenser leads the voltage at its terminals by 90 deg., and exerts a corrective effect directly at its point of connection. The mechanical analogy brings this point out clearly, as may be noted by Figs. 141 to 143, where the condensers are illustrated as elastic bands pulling radially outward, which is the most advantageous direction in which to correct a tendency towards a lowering of voltage. Figs. 142 and 143 especially show the marked voltage sustaining effect of condensers properly situated.

Recent Turbine Practice and its Application to Ship Propulsion.*

IN this and later articles it is intended to give a brief summary of some of the more important papers which were presented at the recent twenty-seventh annual meetings of the Schiffbautechnischen Gesellschaft, held in Berlin last month. The first paper read was one prepared by Professor Dr. E. A. Kraft, entitled "The Modern Steam Turbine and its Application to Ship Propulsion." In introducing his subject the author points out that scarcely ten years ago marine and land type turbines, though alike in principle and theory, were very different as regards their construction. The direct-coupled ship's turbine was essentially a slow-speed machine with a large number of stages, and on the whole only small centrifugal forces had to be taken account of. The main problems of its design were those of constructing a rotor and casing which would resist stresses due to heat and the working of the hull of the ship. High efficiency was not striven after, neither was it attained. In the case, however, of the land type of turbine alternator design soon led to the introduction of higher speeds with a smaller number of stages and higher efficiencies. The increase in the centrifugal and bending stresses, however, soon made it necessary to investigate the critical speeds of shafts, the vibration of turbine discs and blading, and the physical properties of high-quality materials. With the introduction and the more recent success of geared transmission these essential differences between the two types of turbine have now largely disappeared, and the marine turbine designer has a much freer hand. Present-day power station and industrial practice owes much to marine usage in the matters of feed heating and evaporator practice, artificial boiler draught, and the improvement of turbine thrust bearings. Such practice, however, presents in return much that is valuable to the marine engineer in the solution of the problems presented during the next few years.

In the first section of his paper Dr. Kraft considers under three headings the more important of the recent advances in turbine design. Dealing first with the means for increasing the heat drop through the turbine, he illustrates by means of adiabatic curves the effect on the working cycle of high initial pressures and temperatures, saturation and vacuum. The improvements in the high-pressure end of the turbine are mentioned, and the author states that even if they be fully taken into account the use of higher pressures will not give greatly increased turbine efficiencies without a corresponding improvement in the design of the low-pressure end of the machine. An initial pressure of 35 atmospheres, or about 515 lb. per square inch, with a temperature of 400 deg. Cent., or 752 deg. Fah., is given as a figure associated with the newer practice. Dr. Kraft emphasises the necessity for high vacuum, and points out that it can be attained with comparative ease in the marine installation owing to the unlimited quantity of cooling water to hand. The maximum vacuum should be obtained at the last stage of blading, and designs of exhaust passages are illustrated which give a diffusing action and reduce the final loss in the turbine.

In the second part of the first section improvements in the working cycle are discussed and the relative claims of regenerative feed heating and interstage reheating are considered. Investigation would seem to show that no additional advantage is to be obtained by employing more than two stages of reheating, whilst if regenerative working and reheating be applied on the same turbine then the total gain in efficiency is equal to the sum of the individual gains. Under a third heading turbine efficiency is considered, and special reference is made to the necessity of increasing the ratio between the steam section of the nozzles and the leakage section. American tests are quoted to show that with a radial height of nozzle of 100 mm. a theoretical efficiency of 97·5 per cent. is attainable. It falls, however, to 89 per cent. when the radial height of the nozzle is decreased to 5 mm. Taking into account all losses, the corresponding efficiencies are 87 per cent. and 45 per cent. for the 100 mm. and 5 mm. radial heights aforementioned. Economical speeds are next discussed, it being shown that speeds of 3000 revolutions per minute are now in practical use for turbine units of outputs up to 40,000 shaft horse-power. An interesting section of the paper is devoted to the quality figure of a turbine, which may be expressed as a measure of the relation between the square of the circumferential blade speed and the square of the steam velocity which can result

* "Studies of Transmission Stability," by R. D. Evans and C. F. Wagner, Midwinter Convention, A.I.E.E., February 8th to 11th, 1926.

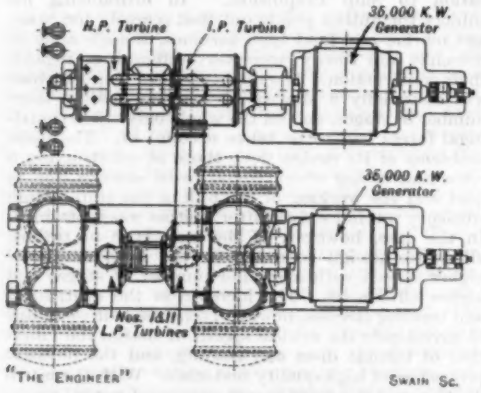
† See paper referred to above for definition of this term.

* Schiffbautechnischen Gesellschaft. Berlin meetings.

from the heat drop. This coefficient is usually expressed as $\frac{\Sigma u^2}{H}$, H being the total heat drop and Σu^2 the sum of the squares of the circumferential speeds of the blades. The relation of this coefficient to thermal efficiency for condensing turbines of 10,000 to 90,000 shaft horse-power is shown. Certain constructional details are dealt with in this part of the paper, and they include the new A.E.G. completely machined nozzle box, also labyrinth stuffing-boxes of both the A.E.G. and American G.E.C. types. Reference is also made to a design of turbine thrust bearing of the pad type, which is illustrated.

In dealing with the main principles underlying the design of economical turbine plants Dr. Kraft emphasises the first importance of reliability and simplicity and quotes the American motto: "Reliability first, last, and every time." In the second place, however, economical working must be striven for and attained, design and workmanship must be correlated, and individual parts of the turbine should so be made as to avoid critical speeds and torsional vibrations.

The application of various principles is illustrated by examples taken from recent A.E.G. practice,



70,000 K.W. TURBO-GENERATOR SET

more especially by the 70,000-kilowatt unit which the firm is building for the new Rummelsburg power station near Berlin. This set is shown in outline in the accompanying illustration. It is a triple-expansion machine, designed for a normal speed of 1500 revolutions per minute, with a total normal output of 70,000 kilowatts and 80,000 kilowatts under overload conditions. The general lay-out of the high-pressure, intermediate and two low-pressure turbines with their

Marine Turbine Schemes.

Total output, S.H.P.	20,000	20,000	20,000	20,000
Number of turbine sets	2	2	2	1
Output of each turbine set, S.H.P. ..	10,000	10,000	10,000	20,000
Number of turbines in each set	1	2	3	2
H.P. turbine, r.p.m.	3,000	5,000	5,000	3,300
I.P. turbine, r.p.m...	3,000	5,000	3,500	3,300
L.P. turbine, r.p.m.	3,000	2,500	2,000	2,000
Quality figure, m^3/s^2				
k cal./k g	2,500	2,650	2,650	2,800
Thermal efficiency at turbine coupling per cent.	78·5	81	82	83
Steam consumption, lb. per H.P.-hour	6·41	6·24	6·15	6·06

separate 35,000-kilowatt alternators is shown by our illustration, together with the condensers and automatic stop valves. In the paper other drawings of the turbines are given and photographs of the various turbine parts going through the shops are reproduced. After dealing with several examples of geared turbine-driven pumping units, Dr. Kraft works out and illustrates a series of plans for a 20,000 shaft horse-power twin-screw geared turbine arrangement, the steam conditions being 35 atmospheres, or 515 lb. per square inch, at an initial temperature of 400 deg. Cent., or 752 deg. Fah., with a 96 per cent. vacuum. A normal propeller speed of 95 revolutions per minute is taken throughout. A summary of the figures for the four different schemes is given in the above table.

The paper also includes a short illustrated description of the machinery arrangement of the King George, engined by the Parsons Marine Steam Turbine Company, and reference is made and a drawing given of a 950 shaft horse-power geared turbine installation built by Escher, Wyss and Co. for a Rhine tug.

Low Temperature Carbonisation.

THERE has just been issued by H.M. Stationery Office the report on a test made by the Fuel Research Board on the "Fusion" rotary retort installed at the works of Electro-Bleach and By-products, Ltd., at Cledford, Cheshire, by the Fusion Corporation, Ltd., of Middlewich, Cheshire. We give below some extracts from this report.

The plant in question has a nominal capacity of 5 tons of coal a day, but during the trials, which lasted for four days, only 3¼ tons of cannel coal were put through every twenty-four hours. The plant, of which a diagram is given in Fig. 1, comprises:—1. A coke-fired furnace, a gas-mixing chamber, and a heating chamber; 2. A revolving retort tube containing loose breakers, an automatic feed valve, an end chamber with diaphragm gland, and an automatic discharge valve. 3. A dust remover, a condenser, a booster and governor, a gas-scrubbing plant, a meter, and a holder.

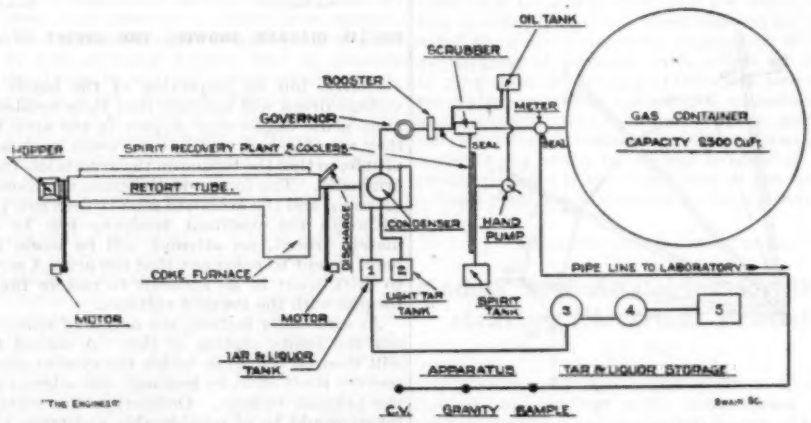


FIG. 1—DIAGRAMMATIC ARRANGEMENT OF LOW TEMPERATURE CARBONISATION PLANT

The retort—see Fig. 2—is a mild steel lap-welded tube, 25ft. long and 2ft. 6in. in diameter, rotating in a horizontal position within the heated brickwork chamber. The retort contains metal breakers, usually five in number, each about 20in. in diameter; they are not fixed in any way, and different types of breakers are used, depending on the nature of the material being carbonised. A ring resting on eight steel rollers, four at each end, carried on spindles revolving in bearings, is fitted at each end of the retort tube, external to the heating chamber. The retort is driven from the charging end by means of spur gearing, the source of power being a 2 horse-power motor. The automatic feeder, driven direct from the retort, is mounted at the feed end. Adjustment of this feeder ensures a uniform flow of material to the retort.

A stationary chamber, into which all the products of carbonisation pass, is fixed at the discharge end of the retort. The lower part of this chamber forms the residue hopper with an automatic discharge valve, maintaining a constant seal of spent material. A considerable amount of coach springs against a metal reinforced asbestos ring mounted upon the retort tube. The thin sheet iron ring is made more flexible by circular corrugations.

The gas and tar vapours leaving the chamber pass to a dust catcher, with a seal at the foot. The excess tar from this seal overflows to an adjacent tank, and from there is pumped to settling tanks. The gas and vapours next pass through a water-cooled tubular condenser, the light oil from this condenser being separately collected. The gas then passes through a booster to a scrubbing plant; from this to a meter; and subsequently to a 2500 cubic feet gasholder.

The coal used during the trial was run-of-the-mine Welbeck cannel intermixed with some 10 per cent. of bituminous coal containing 1·8 per cent. moisture, 46·6 per cent. volatile matter, 36·8 per cent. fixed carbon and 14·8 per cent. ash. It had a calorific value of 12,970 B.Th.U. per lb. It was found that the most satisfactory results were obtained if water was added to bring the moisture up to 5 per cent. As the plant is of an experimental nature, the coal was fed into the hopper by hand, while the by-products were dealt with manually. As a consequence, one superintendent and two men were required for each shift of twelve hours, with an extra man on the day shift. It is considered, however, that in commercial working one man on each eight-hour shift and a day labourer could run the plant. The total power consumption was less than 5 horse-power. The retort was heated by a furnace burning blast-furnace coke and the heat used amounted to 36·1 therms per ton of cannel charged. The flow of heat from the furnace was so arranged that the discharge end of the retort was the hotter, and the temperature of the material being treated ranged from 550 deg. to 600 deg. Cent. Elaborate arrangements were made for securing all the data necessary for reviewing the behaviour of the plant.

The products were:—A residue after carbonisation, gas, spirit from the gas, tar, a mixture of residue, dust and heavy tar, and ammoniacal liquor.

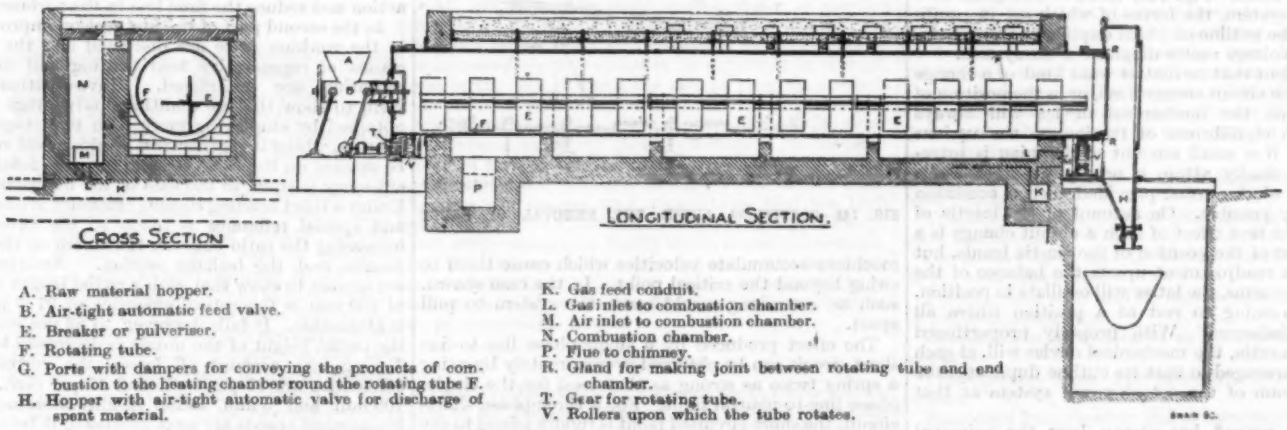
The residue contained 64·8 per cent. of carbon, 25·5 per cent. of ash and 9·7 per cent. of volatile matter. It had a calorific value of 10,850 B.Th.U. per lb., and would, it is said, make a good pulverised fuel if properly ground. It is, however, too small for use in an ordinary furnace as it is discharged.

The gas yield was 2740 cubic feet per ton of coal, and it had a calorific value of 1070 B.Th.U. per cubic foot. It contained a rather large proportion of nitrogen, probably on account of air leakage through the feed hopper.

By scrubbing the gas with American gas oil, 3·75 gallons of crude spirit were obtained for every ton of coal gasified, but this amount would, of course, be reduced in refining the spirit. Its calorific value was 19,870 B.Th.U. per lb., and its specific gravity 0·740.

Three classes of tar were obtained, having specific gravities of 0·815, 0·943 and 0·983 respectively. The total yield was 50·23 gallons per ton, or 72·5 per cent. of the assay yield. It is suggested, however, that the yield could be increased to 54·41 gallons by slight modifications of the retort. The lighter tars could be made to give up 2·60 gallons of spirit per ton of coal. The total pitch in the mixed tar was 131·6 lb. per ton of coal.

The mixture of residue and heavy tar was more or less accidental, and would not collect in an improved plant, so need not be considered here. The tar it contained is accounted for in the yield of 54·41 gallons given above.



A. Raw material hopper.
B. Air-tight automatic feed valve.
E. Breaker or pulveriser.
F. Rotating tube.
G. Ports with dampers for conveying the products of combustion to the heating chamber round the rotating tube F.
H. Hopper with air-tight automatic valve for discharge of spent material.
K. Gas feed conduit.
L. Gas inlet to combustion chamber.
M. Air inlet to combustion chamber.
N. Combustion chamber.
P. Flue to chimney.
R. Gland for making joint between rotating tube and end chamber.
T. Gear for rotating tube.
V. Rollers upon which the tube rotates.

FIG. 2—SECTION THROUGH ROTARY RETORT

of the heavier tar condenses and runs to a seal pot. The condensed tar is removed intermittently by hand to a storage tank adjacent to the plant. The joint between the chamber and the rotating retort is made by a thin sheet iron disc, the outer edges being fixed to the chamber. A ring is mounted on the inner circle and pressed by means

The liquor from the various seals and that extracted from the oil were mixed together and was found to contain 2·98 lb. of pure ammonium sulphate per ton of coal.

In his notes on the report Mr. C. H. Lander says that the yields of tar and gas were satisfactory, and that no serious difficulties were encountered during the test.

Laying a Telephone Cable Between N. and S. Islands, New Zealand.

THE Telegraph Department of the New Zealand Government recently completed the laying of a telegraph cable across Cook Strait between north and south islands. The cable, which was laid by the Government cable-laying steamer Tutanekai, crosses the Strait from a point near the Blind River on South Island to Lyall Bay, near Wellington, on North Island.

To begin with, a short length of cable was laid from the South Island terminus and buoyed offshore. Then the Tutanekai proceeded to Lyall Bay, to begin the laying of the 30 miles or so of cable from the Wellington end. The Lyall Bay end of the cable was first put over the side, and the ship's launch and a surf boat snaked it shoreward. As the cable was paid out over the bow sheave, barrels were lashed to it to keep it from sinking to the bottom, and so making the haul too heavy. When the surf was reached the launch cast off and left the work of getting the cable through broken water to the surf boat. The cable was brought to shore, where a staff of telegraph men were waiting to tail on to the hauling line and drag the cable up the beach, where it was made fast. The end was then opened up for connection to instruments temporarily installed in a shed for the purpose of noting conditions during the laying of the cable.

The ship then weighed anchor and began the journey to the other side of the Strait. The cable passed from the hold first around the drum of a rotometer, which measured the length, then through a dynamometer which recorded the tensile stress, and finally over a large sheave at the forecastle head, whence it trailed away into the sea. Officers on the bridge took frequent observations of various landmarks, so that the ship's course could be plotted exactly on the chart and the line followed by the cable permanently recorded. The ship end of the cable was, of course, connected up with testing instruments, by means of which imperfections in the cable, if any developed, could be detected and measures taken to locate and remedy them. These tests were made every few minutes, and at intervals a telephone was substituted for the testing apparatus, and speech could be held with the Lyall Bay watchers. In both volume and clearness of sound, the words came well over the cable throughout the passage.

The ship having reached the desired spot, the buoy marking the end of the southern shore cable was picked up and hauled aboard. Two experts were put ashore to co-operate with the ship's staff in making the final tests, and as the weather held fine it was decided to go straight ahead with the work of joining up. The main cable, of which a portion remained in the ship's hold, was cut, and the armouring and protective coverings of the actual telephone conductors in the centre were laid back for some distance. Thorough tests of these conductors—four copper wires, number 13 standard gauge—having proved that everything was in thorough order, the work of splicing began. It lasted throughout the night and early morning. The outer coverings were then replaced and strongly protected by additional heavy armouring. That done, the cable was dropped overboard and the ship returned to Wellington, after making a call at Lyall Bay to pick up the mark buoys which had been left there.

The cable—several views connected with the laying of which are given on page 610—is intended primarily for telephone work only, though it could, of course, be used for ordinary telegraphic traffic.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE ELECTRICITY BILL.

SIR,—Lord Sydenham's exposure of the Electricity Bill in its true inwardness shows up this Moscow-bred adventure from one angle. May I be permitted to challenge Lord Haldane's hollow defence of it as a non-Socialistic measure from another ?

Lord Haldane claims that the connection of London to the "grid" will improve its chances in hostile air attack. He omits to point out that a decentralising scheme whereby each district catered for its own requirements both within the metropolitan area and without would render it practically invulnerable.

Now, all said and done, can it even be urged that when interest is paid on capital, and transmission losses are counted in, that power from the "grid" can be much less costly than at present and actually not so cheap as when generated in smaller modern oil-driven stations whose efficiency is very high ? The complete truth is that, not cheaper power, but the will to work both by capital and labour, in their respective capacities, is the answer to foreign competition. Labour, spoilt by political cowardice in the war, is grudgingly returning to harder times. Capital, swollen with easy money, has reared a younger generation that has never worked. It hesitates, now that it is losing money, to launch out into any speculation, and its younger element has been bred to regard the business week as a four-day period. The answer lies above.

No one denies the uses of electrical power, and those countries blessed or cursed with vast reserves of water power must work out their own destinies with the natural conditions they have to their hand ; but it is the hard-living nation that will eventually survive them, even though the term is comparative, and since we have no natural resources to accord us cheaper electricity than we are now obtaining, any attempt to force a hot-house scheme upon the country is clearly a political move and should be instantly turned down. Any over-centralised control of electrical power is a direct step into the maw of world revolution which is the avowed aim of the Moscow group.

A HUMBLE DISCIPLE OF ST. GEORGE.

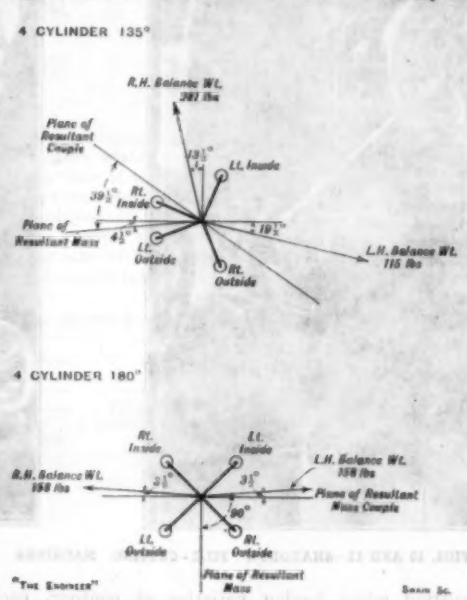
London, November 28th.

SOUTHERN RAILWAY FOUR-CYLINDER LOCOMOTIVE.

SIR,—I have read with much interest the article in your issue of November 12th on the balancing of the new Southern Railway engine. As I have had previous occasion to study the balancing of an engine with this crank arrangement, I may perhaps be permitted to explain the apparent difference in the balancing on the two sides of this engine.

The usual procedure for determining the necessary weights is equivalent to dividing each mass individually between the wheels and compounding these into the balance weights required ; this method is convenient, but it does not readily show the reason for the lack of symmetry.

In place of this method, compound the reciprocating masses, or that proportion of them which it is required to balance, into a resultant mass on the centre line of the engine and a "mass-couple." The rotating parts being completely balanced, need not be considered, although even they will require a large balance weight on one side. The resultants, as found above, may then



be balanced by weights in the wheels, for the resultant mass equal weights in the same angular positions, and for the mass-couple equal weights in opposed angular positions. The two weights so found for each wheel may then be compounded to give the balance weight required, and it is not difficult to see that the resultant weights would only be equal if their components were at right angles—that is, if the radial planes containing the resultant mass and the resultant mass-couple were at right angles. This condition will be found to be satisfied with the two-cylinder, three-cylinder, both 120 deg. and 90–135 deg., and four-cylinder, 180 deg., types ; but it is not satisfied by the four-cylinder 135 deg. type, in reality due to the resultant of the inside motion being inclined to that of the outside and the resultant mass-couple being relatively smaller for the inside.

Diagrams accompany this letter, to explain my meaning by a comparison of the positions of the resultants and the weights for the Southern Railway engine and for an engine with the same weights, but with 180 deg. cranks.

The query raised as to whether the balancing of an engine can be different for reverse running is easily answered. All the forces involved depend on the square of the angular velocity and therefore must remain unaltered with a change of direction of rotation. G. S. GOCUL, M.A. (Cantab.).

Bury St. Edmunds, November 24th.

SIR,—Your description of the new locomotive for the Southern Railway states that the balance weights for the reciprocating parts are divided amongst the three driving axles, but that the amount of the weight in the middle drivers is twice as great as that allotted to the leading and trailing drivers. The intensity of the impact at the treads of the middle wheels is thus 100 per cent. greater than that of the others.

The horizontal component of the pull of the reciprocating counterweights must be transmitted to the frames in order to balance that part of the pressure in the cylinder which accelerates and retards the reciprocating parts. It seems preferable to exert the pull equally through all the hornblocks, and to make the vertical component, which produces hammer blow, equal in each of the coupled wheels. LIBRATO.

November 30th.

[It is true that the "hammer blow" of the intermediate wheels is twice as great as that of either the leading or the trailing wheels, but even so it is still of comparatively small amount, being just over 2 tons for the pair of wheels at 60 miles per hour. It should also be noted that while it is possible to balance 13½ per cent. of the reciprocating masses in each of the three pairs of wheels instead of the 10 per cent., 20 per cent., and 10 per cent. distribution actually adopted, such an arrangement would still leave the hammer blows of the left-hand wheels about 2½ times as great as those of the right-hand wheels. The inequality is a necessary consequence of the peculiar crank arrangement.—ED. THE E.]

CONGRESS OF MINING AND METALLURGY.

SIR,—The selection of Canada as the meeting place of the Second Empire Mining and Metallurgical Congress in 1927, and in recognition of the importance of the Congress in its influence on the development of Canada's mineral resources, the Government of Canada is prepared to assist the Main Committee, in order that the widest possible opportunity may be given visitors from the Motherland and sister Dominions to become thoroughly familiar with Canada's vast and varied resources.

Plans are now being prepared to this end by the Main Committee of the Congress, and these will include a tour of the more important mining and smelting districts of Canada, as well as visits to many points of general interest. This gathering of British mining men from all parts of the world will not only have a beneficial effect upon the mineral industry of the Empire, but will stimulate a spirit of co-operation and comradeship between the men that are engaged in this industry, and on behalf of the Canadian Government I wish to extend a hearty welcome to all who may be able to attend. CHAS. STEWART,

Minister of Mines.

Ottawa, Canada, November 4th.

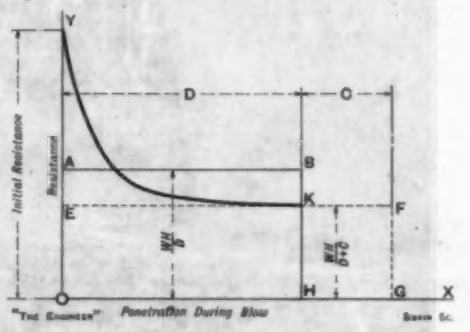
PILE DRIVING.

SIR,—Your correspondent "Monkey" enquires the reason of the difference in the two constants in the formula :—

(*a*) For drop hammer. $L = \frac{12.W.H}{D + 1{\cdot}0}$.

(*b*) For steam hammer. $L = \frac{12.W.H}{D + 0{\cdot}1}$.

I think the accompanying diagram gives a simple explanation of the formula.



The area under the curve represents the work done during the blow (and equals W.H. if no energy is wasted), the end ordinate H K representing the final resistance of the pile, and O H the distance penetrated. If the rectangle O A B H be drawn with a height W.H./D, its area will represent the work done by the hammer, and if no energy were wasted it would equal the area under the curve. If the rectangle O E F G be drawn equal in area to O A B H (which ideally equals the area below the original curve), E F passing through K, H K will represent the final resistance, or ultimate load on the pile, and K F will represent the constant to be added to D in the formula. The area H K F G represents the work done in overcoming the initial resistance of the pile. This empirical value for C is taken as 1in. for drop hammers. With a steam hammer the pile is kept in vibration and does not have time to come to rest between the blows, and the initial resistance for each blow is considerably reduced ; the empirical value is then taken as 0.1in.

H is the "free" fall, and the 12 is, of course, to change feet units to inches. As a factor of safety of 6 is used (this includes allowance for elastic compression of pile), the formula for safe load becomes $\frac{2.W.H.}{D + C}$, the penetration being taken as the average of the last five to ten blows provided they are fairly uniform.

I give this explanation, as nearly as I recall it, from a book I saw when in the United States.

HADDON C. ADAMS,

(Late Asst. Highway Engineer, State of Illinois),

F. C. Construction Co., Ltd., Derby.

Derby, November 29th.

ELECTRIC LOCOMOTIVES.

SIR,—From your report of the proceedings of the Institution of Mechanical Engineers my remarks do not seem to have been so clear as I intended.

It is stated that I took exception to the one-hour rating of the motors of the electric locomotives. What I endeavoured to convey was that as the horse-power of the electric locomotives was based on the one-hour full load rating of the motors, no comparison could be made with the steam locomotive in the matter of horse-power based on an arbitrary ratio between horse-power and grate. To compare the former with the latter, the rating of the steam locomotive should be based on an average drawbar pull at an average speed. J. CONDER.

London, December 1st.

MARINE ENGINEERING STUDENTSHIP FACILITIES.—The Council of the Institute of Marine Engineers desires to draw attention to the Lloyd's Register scholarships awarded under its auspices, one of which is open for competition annually in May. The scholarship, which has a yearly value of £100, is tenable at an approved university in Great Britain or Ireland, and is intended to enable apprentice or junior engineers to take the full degree course in engineering science as a basis of future professional careers in marine engineering or shipbuilding. Candidates for the scholarship must be between the ages of eighteen and twenty-three in September next. Particulars can be obtained from the secretary of the Institute of Marine Engineers, The Minories, Tower Hill, E. 1.

ARMOUR PLATE TRIALS.—Speaking on a paper entitled "The History of Armour Plate" (see THE ENGINEER, February 12th, 1926), which Monsieur Baclé read before the British Section of the Société des Ingenieurs Civils de France on November 24th, Sir Robert Hadfield recalled some amusing experiences in connection with armour plate trials at Gâvres. "One was the wonderful terrier dog, who, after a round was fired, immediately rushed out from the shelter and 'retrieved' samples of the plate or other *debris*. The second was the cow, which fed in the meadows all around and near the Polygon, but marvellously escaped unhurt the many mitrailles coming from the rounds fired. We were even offered a glass of milk from this very accommodating cow. Rather an unusual inhabitant of a Polygon ! Another amusing incident related to the Polygon of his Majesty's Government at Shoeburyness, and to trials carried out there some thirty years ago. A round was fired with one of the Holtzer projectiles, which passed unbroken through the plate and was brought to rest in the sand butt. Close alongside was found a little dead rabbit. Probably no rabbit had ever required such a large expenditure, whether as regards cost or weight of projectile, as occurred in the instance in question."

The Manufacture of Files at Templeborough Works, Sheffield.

By J. W. WALKER (Works Manager).

No. II.*

STRIPPING AND SETTING.

"STRIPPING" is the name given to the process of eliminating the unevenness caused by grinding, and also of removing the deep scratches which unfortunately occur when using natural stones. The operation may be carried out either by means of files or by artificial abrasive wheels. Stripping machines, operating on two, four or more file blanks simultaneously, are often employed, although files having round sides and irregular shapes are usually stripped by hand. The object of the process is to produce a smooth level surface free from deep scratches and irregularities, for without a smooth surface it is not possible to produce, by means of a chisel, teeth having clean true edges free from serrations. Such irregularities are relatively unimportant on bastard-cut files, but it is most important that they should not be present on files that are required for working on tools having sharp cutting edges, as, for example, saws and milling cutters. It is, therefore, necessary that the blanks of such files should be stripped before they are cut. The classes affected are single-cut files, saw files and smooth and second-cut files.

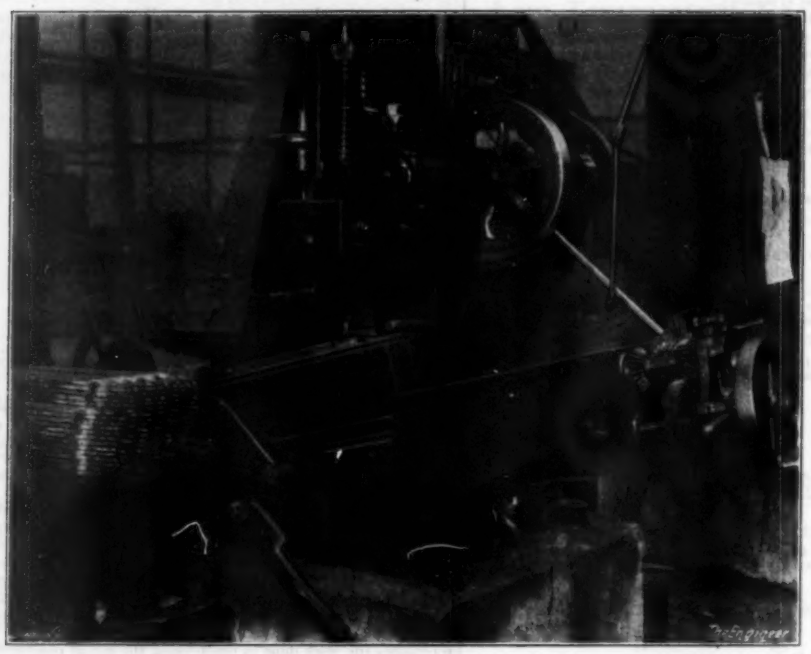
"Setting" is the name given to the operation of chamfering the corners of the surfaces which are to be cut. If the corners are left sharp, the extreme edges of the teeth on the two adjacent surfaces will be weak, and will be liable to fracture during the operation of cutting. Even if fracture does not take place during this operation the teeth at the corner lack material support, and will easily break in use.

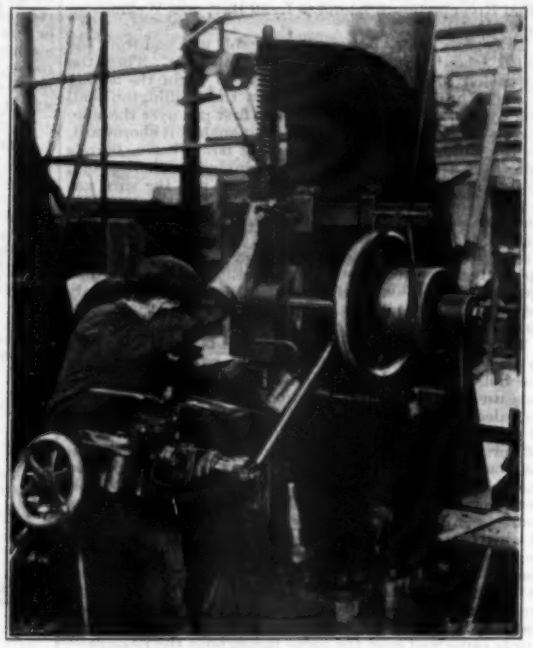
CUTTING: PITCH OF TEETH, ANGLES, OVERCUT, UPCUT, SPECIAL TEETH FOR VARIOUS METALS, AND RAKE.

Files are cutting tools which owe their cutting properties to teeth which are raised up out of the body of the steel. The teeth are formed by the impact of a chisel edge which forms a series of parallel depressions, the displaced material being thrown up to form cutting edges having varieties of contour, each resembling in section, more or less, the tooth of a milling cutter. Single-cut files are so-called because the cutting properties are obtained by a single set of parallel teeth. Double-cut files, however, have teeth which are formed by two sets of parallel teeth which intersect each other at various angles. First, the "overcut" which makes an angle of 45 deg. to 50 deg., with the axis of the file, and secondly, the "upcut," making an angle of 70 deg. to 75 deg. with the axis of the file. Files for brass are specially cut with the upcut at 90 deg., while for wrought iron and dead soft steels the overcut angle is about 90 deg. and the upcut angle about 35 deg. Many other variations are employed on special jobs or different materials. The "upcut" determines the shape and angle of the cutting edge, the "overcut" merely dividing the long teeth into a number of shorter ones which breaks up the chip of the material being filed, thereby affording better clearance and minimising the chance of clogging.

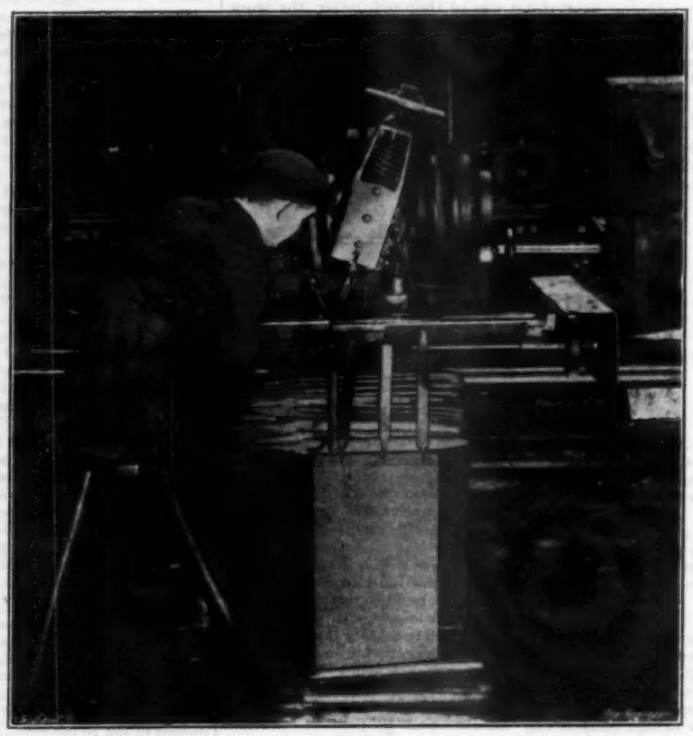
These angle variations, together with the variations of pitch and the ratio of "overcut" to "upcut" cover such a bewildering number of combinations, that it is small wonder no absolute standard exists. The systematic study of this part of file making is long overdue. It would appear probable that there exists one set of factors which would give the maximum cutting efficiency for any given material. That, however, is a subject for the research laboratory rather than for the manufacturer. Single-cut files have the teeth formed at an angle of from 65 deg. to 85 deg. to the axis of the file. It is found that this type of tooth leaves a cleaner edge on the saw or tool which is being filed than is possible if a double-cut file is used. Saw files for use on very hard material are, however, usually ordered "double-cut." In the case of rough-cut files and coarser single-cut files sometimes known as "float cut," the teeth are so large that they do not easily clog. It is therefore unnecessary in that class of file to break up the chip by means of double cutting, since the teeth are self-cleaning.

Files of all types and sizes have variations in the pitch or number of teeth per inch. These variations in cut are denoted in the file trade by the following general terms:—"Rough," "bastard," "second-cut," "smooth," and "dead smooth." There are other





FIGS. 10 AND 11—SHARDLOW FILE-CUTTING MACHINES



FIGS. 12 AND 13—HESS-TYPE FILE-CUTTING MACHINES

* No. I. appeared November 26th.

classes, but they are not usually stocked, and as they are relatively unimportant they are not included in this consideration. The following table shows the number of teeth per inch in both the "overcut" and "upcut"—measured along the axis of the file—for the various sizes and classes of files mentioned above; but it may be remarked that considerable latitude, particularly in the case of the "overcut," may be allowed without affecting the efficiency of the file.

Teeth per inch.

Type.	Length in inches.														
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Rough (often single-cut)—															
Overcut	20	20	17	17	15	15	13	13	11	11	9	9	8	8	7
Upcut	24	24	21	21	19	19	17	17	15	15	13	13	12	12	11
Bastard—															
Overcut	24	24	21	21	19	19	17	17	15	15	13	13	11	11	10
Upcut	28	28	25	25	23	23	21	21	19	19	17	17	15	15	14
Second-cut—															
Overcut	38	38	36	36	34	34	32	32	30	30	28	28	26	26	24
Upcut	32	32	30	30	28	28	26	26	24	24	22	22	20	20	18
Smooth—															
Overcut	48	48	46	46	44	44	42	42	40	40	38	38	36	36	34
Upcut	46	46	44	44	42	42	40	40	38	38	36	36	34	34	32
Dead smooth (usually double-cut)															
Overcut	80	80	76	76	73	72	68	68	64	64	60	60	56	56	52
Upcut	76	76	72	68	68	64	64	64	60	60	56	56	52	52	48

The actual cutting operations are now almost universally carried out by machines, though certain types are still cut by hand, notably Lancashire files having very slim points, which make the cutting operation exceedingly delicate to carry out successfully by hand and almost impossible by machine. The whole controversy regarding the relative merits of hand and machine-cut files is almost dead, and where it is commercially practicable to cut by machine that method is invariably employed. The types of machine used, of course, vary in different countries

FIG. 14—TEETH OF MACHINE-CUT 14in. FILE

and for different classes of work. At the Templeborough works the following machines are in general use:—

(*a*) The Shardlow machine for heavy work.
(*b*) The Hess machine for medium and light work.
(*c*) The sliding-back machine and machines of special construction for very light work, such as saw file edges, &c.

The underlying principle in all these machines is

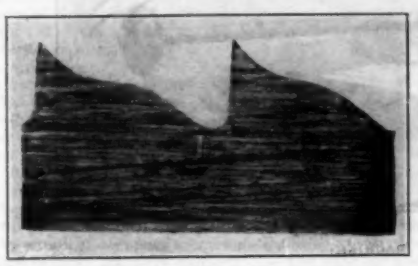


FIG. 15—TEETH OF HAND-CUT 14in. FILE

identical. The work is supported on a sliding table capable of moving at definite but variable rates along the main bed of the machine. A hammer head or plunger is raised by means of a cam, and is caused to rebound by means of a spring or rubber cushion. At the lower end of the hammer a chisel is securely fastened, and the force of the blow is expended at the chisel edge, which is suitably ground and whetted to give the required form of tooth. Some machines have an inclined table and vertical head, whilst others have horizontal tables and inclined heads. In either case the inclination of one to the other is usually adjustable within small limits, and the angle formed by the face of the teeth and the surface of the blank is approximately the same whatever type of machine is employed.

The number of blows per minute varies according to the size of the machine, and ranges from about 600 blows per minute in the case of the large machines to about 2000 blows per minute for the small machines.

Half-tone engravings reproduced from photographs of actual machines are given in Figs. 10, 11, 12 and 13, and from them a good general idea of the various machines may be gathered.

If the rake or inclination of the cutting face of a tooth to the surface of the file blank be examined, a casual glance would lead one to suppose that the face of the tooth leans forward, *i.e.*, in the direction of the cutting stroke; or, in other words, has a positive rake. Further examination, however, will show that the majority of ordinary commercial files have a negative rake, which may vary from 5 deg. to 15 deg. It is admitted that teeth having a positive rake will cut more readily and sweetly than those having a negative rake, and some manufacturers claim to be able to produce teeth with a positive rake by ordinary machine-cutting methods. A careful investigation of files of many makes taken from commercial stocks shows, however, that very few files indeed have teeth with positive rake. It is claimed that the rake of the teeth of the files produced by machine cutting at the Templeborough works is as close to the ideal as it is possible to get. The alternative method of milling and grinding gives a more definite positive rake, but is so much more costly than machine cutting that it has no hope of seriously competing with the cutting machine except on files for special work.

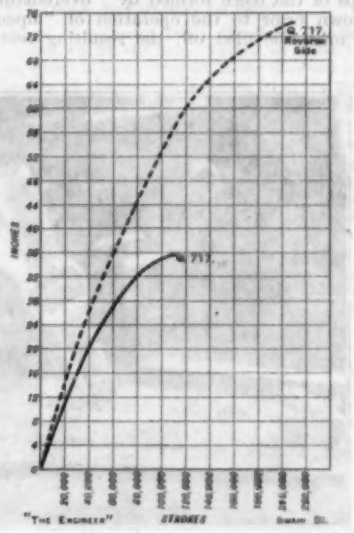


FIG. 16—DIAGRAM OF TEST

Photographs illustrating the above points have been taken from both machine and hand-cut files and are reproduced in Figs. 14 and 15. The 14in. hand bastard file was taken at random from files forming part of a large order for a foreign railway company. The inspector sent this file to the Sheffield Testing Works, and the result of the test was so remarkable that one side of the file was tested to destruction, with the result that over 74in. of 1in. square standard steel test bar was filed away before the file ceased cutting, the average cutting rate being 3·58 cubic inches per 10,000 strokes. A copy of the report on the test, together with a reproduction of the diagram which accompanied it, are given in the table above and in Fig. 16. Even on this file, which shows remarkably quick cutting and lasting properties, the rake is negative, whilst the hand-cut file shown in Fig. 15 has teeth with a rake that is almost positive. There was a remarkable difference in their relative performance on the testing machine, from which it may be gathered that there are more important

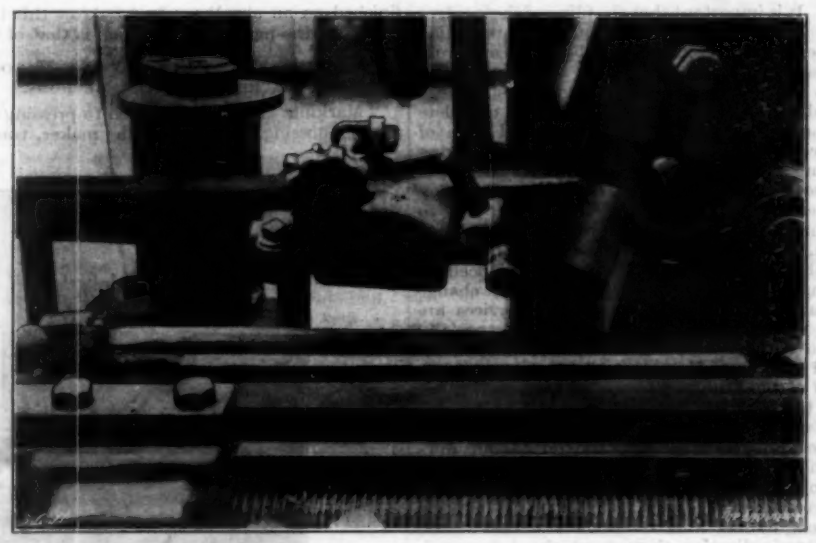


FIG. 17—CUTTING ROUND FILE

Results of Mechanical Tests Carried Out by the Sheffield Testing Works, Ltd., on One File Received from Sheffield Steel Products, Ltd., Sheffield.

Test number.	Described as.	Marks on side of file tested.	Pitch. Number of teeth per inch.	Strokes. Length in inches.	Strokes. Number per minute.	Strokes. Total number.	Pressure on file, lb. per sq. inch.	Duration of test. Hours.	Duration of test. Mins.	Amount of material removed. Weight in pounds.	Amount of material removed. Length in inches.		Condition of file after test.	Material operated upon.
Q717	14in. hand bastard file	Produx F.S.B.	21	6	51	108,000	30	35	18	10·10	35·70	Total. 110·30	Blunted and choked	1in. by 1in. Annealed steel analysis. Carbon .. .. 1·00% Silicon .. .. 0·20% Sulphur .. .. 0·031% Phosphorus .. 0·039% Manganese .. 0·34% Brinell hardness number = 179.
		Sheffield Steel Products S.P.R.	21	6	51	208,000	30	67	58	21·11	74·60		Ditto	

factors than the rake, important as that undoubtedly is.

Another leading point affecting the efficiency of the tooth as a cutting tool is the manner in which the tops of the teeth formed by "overcutting" are filed down prior to the operation of "upcutting." If too much be filed off, the resulting teeth after "upcut" will be flat on the top, and although better able to resist fracture, will require much more pressure to make them bite. On the other hand, if too little be filed off, the resulting teeth will be too thin at the top, and although such teeth will cut more rapidly they are not sufficiently strong, and will break at the cutting edge under comparatively light pressure. It is important that the filing of these ridges should be both uniform and smooth if the resulting teeth after "upcutting" are to be of clean, well-formed, cutting shape.

Details and general lay-out of cutting shops are illustrated in Figs. 17, 18, 19, 20, and 21. A complete description of the composition, shape and sizes of the many beds required for supporting files during the cutting operation lies outside the scope of the present notes. It is, of course, necessary to employ in their construction alloys sufficiently soft not to cause damage to newly cut teeth in their unhardened condition. Yet the alloy must be hard enough to support the files under the rapid shocks produced by the cutting chisel for a reasonable time without change of contour. Beds fitted with indexing devices are used for round files, and cast iron beds specially shaped to suit the contours and used for curved-sided and half-round files.

Details of the number of rows of teeth which are required to cover the curved surfaces of half-round and similar files, also the different methods of cutting round files, spirals, single-cut, and double-cut rows for the many sizes involved are omitted, as there is no recognised standard. The subject is certainly of a controversial nature, but it is time that the question was thoroughly discussed and some standard agreed upon. Standardisation throughout the industry is long overdue.

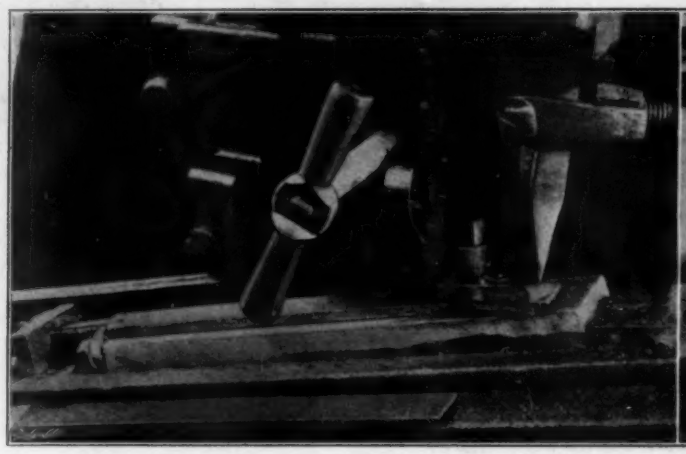


FIG. 18—CUTTING HAND FILE

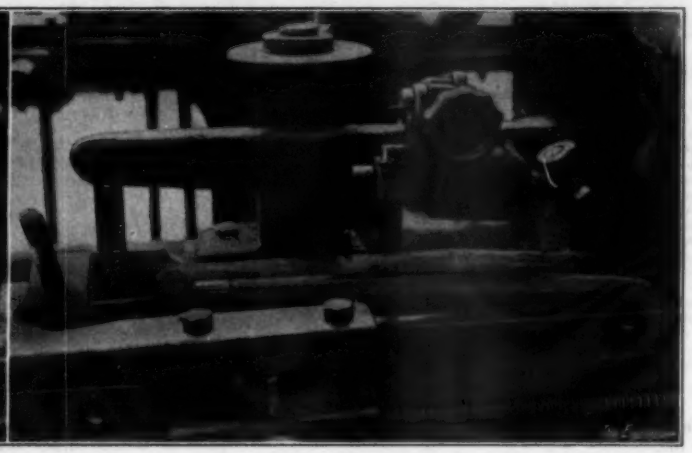


FIG. 19—CUTTING HALF-ROUND SIDE

SNAPING.

Files are cut from point to tang, *i.e.*, the teeth at the point are the first to be cut, the operation finishing at the tang end of the file. The first few blows of the cutting chisel are used as a guide to the cutter; experience and practice enable him to judge the correct depth of cut for the particular file he is engaged in cutting, but the first few teeth which are cut usually lack uniformity. After the cutting operation the files are cropped to the correct length—that is, sheared off and ground square—the operation being known as "snaping." This operation is omitted in some types of file, in fact, files which are not used at the point, *e.g.*, saw files, reaper files; while many other special files are left "not cut to point" and the snaping operation is unnecessary with them except for length and general appearance. But where the file is to be capable of use at the extreme point snaping is necessary, as it removes the irregular and often badly cut trial teeth and leaves good teeth at the extreme point.

The machine used for the operation is a simple form of guillotine punching machine having a worm-driven excentric shaft, with a slide carrying the movable blade, the trimming of the sheared ends being finished on an abrasive wheel. After this the file is ready for the next process, which is that of marking.

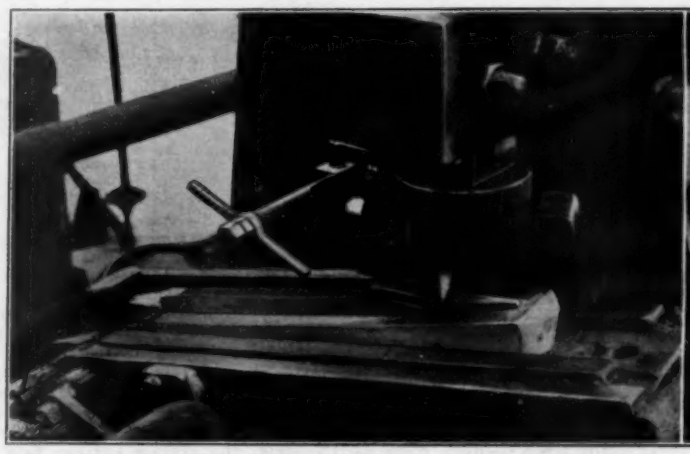


FIG. 20—CUTTING SQUARE FILE

FIG. 21—CUTTING SAW FILE EDGE

MARKING: HAND FLY PRESSES, HAND AND MACHINE MARKING METHODS.

"Marking" is the name given to pressing or otherwise embossing the name of the maker, trade mark, and other necessary particulars required by the manufacturer. The operation is usually done under hand fly presses of various weights depending on the size of the mark to be struck.

Many machines and special devices are in use with the object of speeding-up this process, and of producing clean sharp impressions, so as to give the file a good appearance. The appearance of the file is important, and good marking is essential from this point of view. Moreover, in the event of a desire on the part of some satisfied user to requisition further supplies, it is of importance that the origin of the goods be clearly set forth. One machine used for the purpose is the power-driven screw press which automatically marks the files, the operator merely feeding the files to and from the marking beds. Another type has a spring-loaded punch holder, which is raised by means of a cam that is power operated. The punch is raised to the top of the stroke, the cam being so formed that immediately that position is attained the punch is brought under the influence of a spring which causes the punch to descend and strike the mark. One objection to this type is the liability to strike two impressions, owing to a second return of the punch after its rebound from the first blow. At the Templeborough works special machines are employed which enable two, three, or four sides to be marked at one positive stroke of the machine without any fear of double impressions. The punches are pressed home and not caused to give an impact on the file. Of course, in this, as in any other marking machines, it is essential to have well-cut marks in order that the resulting impression shall be clear and sharp. (See Fig. 22.)

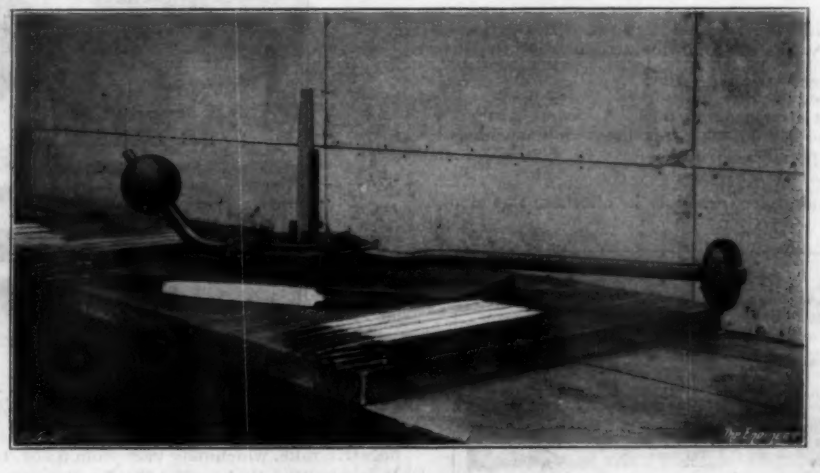


FIG. 22—MARKING MACHINE

Railway Matters.

THE total approximate gross earnings of the Indian State Railways up to October 9th, 1926, amounted to Rs. 48·67 crores, or Rs. 27 lakhs less than the figures for the corresponding period of the previous year.

SINCE the mention in our issue of November 26th of the new station at Epsom, particulars have been issued by the Southern Railway Company. It is, as we anticipated, to be erected at the junction, and will have two island platforms, each 650ft. long.

THE blue book on the railway accidents during the first quarter of the present year contains also thirty-six reports by the assistant inspecting officers on the more serious accidents to railway servants. Of them, ten were fatal, of which four were ascribed to misadventure, four to want of care, and two to no look-out man being provided.

IN this column of our issue of October 1st we mentioned that it had been reported that Mr. J. H. Thomas had been invited to be a member of the Standing Committee on Mineral Transport, recommended by the Coal Commission. A question addressed to Colonel Ashley a fortnight ago elicited the information that the Committee was being formed but was not yet complete.

THE Commissioner of New South Wales Railways (Mr. J. W. Davidson) says that good progress was being made with the earthworks and cuttings for the Kyogle Railway. The work on the cuttings was being done all the way to the summit of the range dividing Queensland from New South Wales, and up to the point where the big tunnel would be put through. Work on the tunnel had not yet begun on the Queensland side.

IT is announced that Sir Charles Innes, Railway and Commerce Member, Government of India, will shortly have a discussion at Trichinopoly with the Agent, South Indian Railway, regarding railway development in this Province. It is understood that the work in connection with about six chord lines is going on satisfactorily and the construction of nineteen lines is being investigated. Electrification of the suburban line is also under consideration.

ONE of the requirements resulting from the Railway Employment (Prevention of Accidents) Act, 1900, is the provision of water gauges on tenders so as to render it unnecessary for enginemen to go to the back of the tender to measure the water available. In the report of an accident to a driver on the Southern Railway it is said that "Enginemen apparently place but little reliance on these fittings and are therefore apt to overlook the reporting of defects in them."

THE Bombay correspondent of *The Times* cables, under date November 24th, that Sir Lawless Hepper was retiring on the 30th from the position of Director of Development for Bombay. Although Sir Lawless ceased to be connected with railways in 1920, when he left the East Indian Railway to take up the work in Bombay, his fourteen years as deputy agent and then as agent to that system will long be remembered for the remarkable development and progress of the line.

THERE were a few railway accidents in the dense fog of Wednesday evening and Thursday of last week. The most serious happened on the former day, when two passenger trains were in collision near Gale-street on the Tilbury section of the London, Midland and Scottish Railway. About seventy persons were hurt, but only two had to remain in the hospital. The following evening the East Coast train due at King's Cross at 6.15 was run into when standing outside Finsbury Park Station. The personal and material injury there was very slight.

THE case of a fatal collision between a train and a motor road vehicle between Thetford and Attleborough on October 27th has taken a serious turn. The gates were open for the roadway, and the motor lorry was crossing when a goods train ran into it. The ordinary gatekeeper was away through illness, and his duties were being performed by a porter, who had to act in accordance with bell signals from the adjacent signal-boxes. Apparently there was no interlocking of gates and signals. The porter has now been committed for trial on proceedings taken by the police.

THE Parliamentary Notices as to the Railway Bills to be deposited next session are as bare as they were in war time. The London, Midland and Scottish Company wishes to give a junction from the westerly or Nottingham direction on to the Southwell branch and to construct a curve from the former Midland main line at Oakenshaw in a south-easterly direction on to the former Lancashire and Yorkshire Wakefield and Goole branch at Crofton. The Great Western proposes a deviation on its Falmouth branch, whilst the Southern, in addition to further proposals in connection with the docks at Southampton, seeks for an extension of time for the construction of the Wimbledon and Sutton Railway. At the time of writing no notice has appeared on behalf of the London and North-Eastern Railway.

THE evidence given on November 25th and 26th at the Ministry of Transport inquiry into the Rawmarsh Railway disaster of Friday, November 19th, showed that a privately-owned wagon on the down mineral train collapsed when approaching Rawmarsh South box and fouled the space between the line on which it was running—the down slow line—and the up fast line. Other wagons then left the rails, and the piled *débris* apparently knocked over a signal post, and the latter, striking the carriages of the express from York on the up fast line, ripped the sides out. A carriage and wagon foreman gave the opinion that the intermediate drawbar had broken some days previously. The through rods also were broken, which would lead to the collapse of the wagon. The foreman added that he would not expect a carriage examiner to discover the defects in an ordinary inspection. The outdoor assistant to the carriage and wagon superintendent said that if a wagon examiner found a defect in a wagon serious enough to warrant a vehicle being withdrawn from service, it was taken off and no one could dispute his authority. Sir John Pringle, in concluding his inquiry, remarked that the accident seemed to be one of those in which it was rather difficult to see that it could have been prevented.

Notes and Memoranda.

THE total value of imports into New South Wales during August was £6,322,324, as compared with £5,472,246 in August, 1925, states the Newcastle (N.S.W.) Chamber of Commerce *Journal*. There were substantial rises in imports of machines and machinery, steel plates and sheets, rubber goods, pneumatic tires and printing paper. Chassis for motor cars show a decline in value, but this is attributed rather to reduction in prices than to any lessened volume.

IN the course of a lecture given before the Wigan Past and Present Mining Students' Association, Mr. F. J. Harlow said that a preliminary X-ray examination must be of considerable assistance in the classification of coal in that it enabled one to get valuable information as to the nature and mode of occurrence of the non-combustible foreign matter associated with the coal. Further, by being able to pick out readily the purest lumps of coal in the sample from which the intrinsic ash might be determined, the limit beyond which it was impossible to go in the washing process was readily obtainable.

FOR the storage of vegetable and animal oils concrete tanks have been in use for many years storing such products as cotton seed, coconut, peanut, fish and various other vegetable or animal oils. Most cotton seed oil companies use no special interior finish. A concern in Seattle, which has tanks of 400,000 gallons for soya-bean, peanut, fish oil, &c., has treated the interior of the tank with water-glass. A Philadelphia manufacturer uses concrete tanks for storing coconut oil and glycerine. While there is some tendency for the lime in the hydrated cement to saponify fatty oils, the resultant insoluble lime soap builds up a protective coating which prevents further attack.

ACCORDING to a message from Vancouver, a system has been evolved by which a high-grade pig iron can be extracted from the black sands of the Pacific Coast islands. An experimental plant, using British Columbia black sands, has been working for some time at Seattle, and it is planned to establish a plant at Port Moody, B.C., costing 160,000 dollars, with a daily capacity of 30 tons of pig iron. The black sand is said to have been found to yield a high grade of iron. There are huge deposits of this sand in the Queen Charlotte Islands, and in the bed of the Tulameen River, but interest has hitherto centred on their gold content, while at present a quantity of platinum is being washed.

BAVARIA has, including plant still being built, about 11,600 water power stations, with a total capacity of some 934,000 horse-power. The total capacity of the larger plants amounts to 745,000 horse-power, of which 375,000 horse-power provides electric light and power for general purposes, 128,000 horse-power for the electric railways, 185,000 horse-power for the electro-chemical and electro-metallurgical industries, 28,000 horse-power for the textile industry, 25,000 horse-power for the paper and press industry, and 4000 horse-power for other purposes. The water power already in use, together with that capable of use according to examinations so far made, reaches a total of 1,100,000 kilowatts.

A PAPER, just issued by H.M. Stationery Office on the permeability of Portland cement concrete, describes experimental work conducted at the building research station of the Department of Industrial Research on the factors affecting the permeability of concrete with a view to determining their relative importance. The subject is considered under three heads, namely, (1) the effect of variations in the constituent materials, (2) the influence of the method of preparation, (3) the effect of subsequent treatment. The experiments have been conducted, in most cases, on slabs 2in. thick, and particular attention has been paid to the influence of water content, since this has been shown to be very large. The various other factors arising from changes in the constituent materials are each discussed, and, as far as possible, experimental evidence is given to indicate the effect of variations on them.

IN a lecture on the properties and engineering uses of stainless steel recently given by Mr. R. Waddell before the Liverpool Engineering Society, mention was made of the experience obtained when using this material in the construction of a valve passing hot sea water on board the Adriatic. The valve was of the single metallic-disc type with a guard attached by a central stud to the seat, the disc moving between the guard and the seat. The seat, disc, guard and stud were originally all made of high chromium high nickel steel, and it was found that after only eight days' service the disc was so badly pitted as to be useless. The disc was replaced by one of the same material, but of twice the original thickness, and after sixteen days' service this was also found to be so badly pitted as to be useless, although the seat, guard and stud were absolutely unaffected. A third disc was then fitted, made of straight chrome steel containing 20 per cent. of chromium, and when last examined, after 4½ months' service, it was found to be in the same condition as when fitted. It has been found that stainless steel will not slide, under pressure, on stainless steel without seizing.

THE following details of the production of coal in Czecho-Slovakia have been forwarded to the Department of Overseas Trade by the Commercial Secretary at Prague:—In 1925 the total production of black coal amounted to 12,754,456 tons, of which 3,061,730 tons were produced in the first quarter, 2,848,504 tons in the second quarter, 3,190,089 tons in the third quarter, and 3,645,133 tons in the fourth quarter. The total of lignite produced was 18,789,098; 4,669,793 tons in the first quarter, 4,114,356 tons in the second quarter, 4,606,889 in the third quarter, and 5,398,058 tons in the fourth quarter. According to monthly results, the production of black coal in 1926 was 3,314,342 tons in the first quarter, 252,612 tons more than in the first quarter 1925; 2,813,879 tons in the second quarter, 34,625 tons less than in the same period 1925; and 3,629,951 tons in the third quarter, 439,862 tons more than in the third quarter 1925. The lignite produced in the first quarter 1926 amounted to 4,794,184 tons, 124,391 tons above the production of the first three months 1925; in the second quarter to 4,145,362 tons, 31,004 tons more than in the second quarter 1925; in the third quarter 4,496,343 tons, 110,546 tons less than in the third quarter 1925.

Miscellanea.

A START on the construction of the Windsor–Detroit tunnel is to be made on February 1st next.

THE output of asbestos from Rhodesia during last year amounted to 34,349 tons, valued at £766,381. A new milling plant is being erected at the Shabani asbestos mine to handle all the rock as it comes from the quarries. The capacity of this plant will be about 60,000 tons of rock per month.

A MEETING was held at the Home Office on November 25th of representatives of the shipbuilding employers and the shipyard trade unions to consider draft rules and regulations which have been drawn up and issued to both sides. These, it is proposed to apply to shipbuilding and ship-repairing establishments.

THE Royal Aeronautical Society announces that the Wilbur Wright Memorial Lecture to be delivered next May will be given by Professor Prandtl, of Gottingen University. Professor Prandtl is, of course, the world-famous authority on aerodynamics, and his lecture will be one of outstanding importance. It will be delivered in English.

THE *Aftenposten*, of Oslo, states that Monsieur Hermod Petersen, Chief Engineer of the Norwegian Telegraph Administration, who for a number of years past has been carrying out experiments relating to the broadcasting of portraits and pictures, now claims to have solved the problem. The results of his experiments will be shown to experts this week.

THE Society of Chinese Architects has been organised by a number of Chinese architects in Shanghai. The society aims to become the nucleus of a national institution of Chinese architects, more or less similar to the Royal Institute of British Architects, and to create public interest in architecture by establishing architectural competitions and by holding exhibitions.

IN order to cheapen the export of coal *vid* Hull and other eastern ports, the proprietors of Thorne Colliery, near Doncaster, propose to construct a railway over 4 miles of moorland to the inland port of Goole, where they will construct wharfage. A saving of 1s. 6d. a ton on transport charges is estimated, and the colliery is expected to reach a production of 30,000 tons weekly.

DURING the first six months of this year there were produced in America 209,022,800 lb. of paste paints, comprising 129,343,800 lb. of pure white lead in oil; 11,634,300 lb. of combination or graded whites; 3,502,500 lb. of zinc oxide in oil; and 64,542,200 lb. of other paste paints; 45,402,100 gallons of ready-mixed and semi-paste paints, including enamels; 38,081,400 gallons of varnishes, japans and lacquers, other than pyroxylin; and 10,136,800 gallons of pyroxylin (nitro-cellulose) varnishes or lacquers.

PLANS for a three-year programme of road construction, the most extensive ever undertaken in the province, are being got out by the British Columbia Public Works Department for the approval of the Legislature at its forthcoming session. At the end of the three years, as a result of a policy of improvement rather than new construction, British Columbia's whole highway system will have been rebuilt. The purpose of this scheme is, first, to give all the settled areas of British Columbia communication with the trunk highways, and thus with all the main centres of population; and, secondly, to rebuild and re-locate all the bad sections of existing roads.

WORK is proceeding on the enlargement and improvement of Antofagasta port with the view of avoiding the present inconvenient and expensive loading and unloading of merchandise which necessitates vessels anchoring at a mile to 1½ miles from the shore in an open roadstead. Passenger vessels can now moor within the main breakwater. The works in hand include a well-protected basin, formed by two breakwaters, one 1450 m. and the other 240 m. long. The piers, with an aggregate length of 1318 m. within the breakwaters, will afford access to ships drawing 36ft. of water. This portion of the undertaking is expected to be completed by July, 1928, and the estimated cost is 19,000,000 dollars.

THE joint board of Canadian and United States engineers which has been studying the problems of the deep-water development of the Great Lakes and St. Lawrence waterways for the past twelve months, has placed an inconclusive report in the hands of Mr. Robb, the acting Premier. The Canadian and United States engineers disagree. Briefly, the Canadians propose the construction of double-stage hydro-electric development, yielding 2,619,000 horse-power, at an estimated cost of 309,000,000 dollars. The United States engineers advocate single-stage development of about the same amount of power, costing 290,000,000 dollars. In either scheme, the estimated cost of improving the St. Lawrence for navigation would be 168,000,000 dollars. The total expenditure on the works between the head of the Lakes and Montreal under the Canadian plan would be 583,000,000 dollars. Under the United States plan 553,000,000 dollars, including canalisation work and counteraction against the effects of the Chicago water diversion.

A METEOROLOGICAL station has been established on the Pratas (Doongsha) Shoal. On July 27th it began to issue weather forecasts and typhoon warnings, says an announcement by C. C. Hsu, director of the Coast Guard Administration of China, Woosung. The weather forecasts and typhoon warnings are based on its 6 a.m. and 12 noon weather map of the Far East. The weather forecasts are broadcast daily on both 600 m. spark transmitter and simultaneously on 1450 m. continuous wave transmitter at 2 p.m. and 7 p.m. of the 120th meridian time, (0600 and 1100 G.M.T.). The typhoon warnings are broadcast in the same way, but are repeated every three hours. The object of establishing the station is to ensure greater safety for navigation in the Far East. The duties of the station will be devoted to meteorological work only. The radio service will, when practicable, accept and transmit, free of charge, messages from any ship that has range difficulties. The call letters of the station are "XPI," and the (new) International Meteorological Codes, the International Code of Signals, and plain English are used.

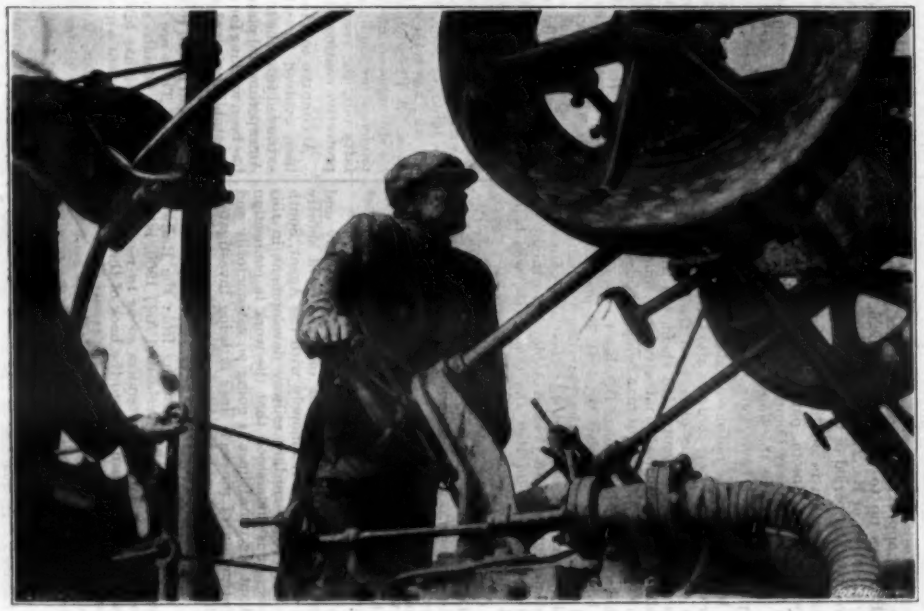
LAYING A TELEPHONE CABLE BETWEEN NORTH AND SOUTH ISLANDS, NEW ZEALAND

(*For description see page* 605)

TAKING IN BUOYS MARKING SHORE END OF CABLE

LANDING THE SHORE END, NORTH ISLAND

CABLE PASSING OVER DYNAMOMETER



CONTROLLING THE PAYING OUT OF THE CABLE

AGENTS ABROAD FOR THE SALE OF

The Engineer

BUENOS AIRES.—MITCHELL'S BOOK STORE, 576, Cangallo.

CHINA.—KELLY AND WALSH, Limited, Shanghai and Hong Kong.

EGYPT.—CAIRO EXPRESS AGENCY, near Shepheard's Hotel, Cairo.

FRANCE.—BOYVEAU AND CHEVILLET, Rue de la Banque, Paris. CHAPELOT AND CIE., 136, Bld. St. Germain, Paris.

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THE ENGINEER.

DECEMBER 3, 1926.

The Training of Engineers.

SOME weeks ago Sir Theodore Morison, Principal of Armstrong College, read a paper entitled "How should an Engineer be Trained?" at a meeting of the North-East Coast Institution. In it he invited the Institution to form a committee to answer a number of questions bearing upon the connection between college education and workshop training. Amongst these questions we find the following: Is workshop experience necessary before beginning to study the scientific principles of engineering? Should the university teach scientific principles or engineering practice? and What training in practical engineering should be given by industrial firms (*a*) to graduates in engineering, (*b*) to students from technical colleges? The other questions are less general. They refer primarily to the courses given in Armstrong College, and in the technical colleges on the North-East Coast. At the end of the adjourned discussion which followed the reading of the paper, the Chairman announced that the Institution had accepted Sir Theodore Morison's proposal, and had formed a committee to consider the questions which he had propounded.

There is no body in the world which has shown a more active interest in the training and education of engineers than the North-East Coast Institution. Centred as it is right in the heart of a great industrial area, it is kept constantly in touch with the problems which surround the upbringing of the young men who in the future are to carry on the great engineering and shipbuilding works of Tyneside and neighbouring districts. It is characteristic of it that it should have hastened to agree to institute an inquiry, and its report will be studied in every quarter of the country with the deepest interest. We ourselves are delighted that it should have taken this step, for we have urged for some years past that the time has arrived when the education and training of engineers should be reviewed. Many years have elapsed since the last revision was made. In the meantime, great changes have taken place. Workshop practice has been modified in many respects; new branches of engineering have come into existence; and the scientific spirit has entered factories more deeply than before. The difficulty of adequately covering the whole ground has increased enormously in the last twenty years, and whilst the universities and colleges have manfully endeavoured to make their courses correspond with the needs of the day, they have only done so by straining education almost to the breaking point. That they should now turn to the industry and ask it for guidance is both natural and wise. If we have any regret at all in the matter, it is that the two parent institutions were not approached, so that the problem might have been faced in a national instead of a local spirit. Moreover, whilst Sir Theodore Morison's questions cover a good deal of ground, they leave many important matters untouched. Take, for example, the enormous expenditure which is incurred by colleges and universities in the maintenance of laboratories. We say "maintenance" because in many cases the equipment is presented by generous donors or by firms with half an eye upon advertisement. In some cases the items of plant are so big that they can be rarely used; in others, they are so elaborate that in the employment of them a fairly large group of students is required, with the result that not one of the group is able to grasp the whole process; in other cases expensive apparatus is put in the hands of quite inexperienced young men, and is soon reduced to mal-adjustment; in other cases there are great workshops which are costly to run and costly to keep up, but of which the value to students is problematical indeed. The expenditure in rent, in attendance, in valuable space, and in upkeep upon such things must place a heavy burden upon the annual incomes of colleges. Is that expenditure worth while; is it pulling its weight? That is a crucial problem which ought to be very earnestly considered. Even at the present time the teaching staffs of nearly all colleges are underpaid, and in many cases they are in consequence inadequate or inefficient. We are told that in that respect the future will be worse than the present. Would it not be better to spend more money on men and less on equipment? It is quite certain that those who look upon workshop training as an absolutely essential part of the education of engineers are in a great majority, and we believe the general feeling is that some preliminary workshop experience, even if it be no more than can be secured in the long vacations, is very desirable. That being so, can we regard the very few hours in their whole college course which students can give to workshop practice as worth the great cost which the maintenance of workshops involve to the college or the extra expense to which parents are put on the purchase of tools which are scarcely used. Again, is it really necessary, is it really desirable, to put in the hands of students physical and electrical apparatus of high quality? Our experience of students is that they rarely or never get the results from apparatus that they are led to expect. A system of intelligent "cooking" prevails, and is inevitable when delicate apparatus is placed in the hands of inexperienced operators. Some of the smaller colleges have to be content with much less elaborate plant, and we are inclined to think that its educational value is higher.

Such practical issues as these, which we have space to indicate but briefly, may, we trust, be covered by the committee which deals with Sir Theodore Morison's questions. But its terms of reference are somewhat restricted. Throughout its inquiry it will inevitably keep Armstrong College in view. Hence, whilst it can scarcely fail to give answers meriting far wider application, it will not speak with national authority. It is not the position in Tyneside alone that requires examination, but the position in every educational centre in the kingdom. The training that is given to engineers is of the first importance to the nation as a whole. The industry they are to serve is in itself amongst the three greatest in the world, and there is scarcely a single industry upon which it does not impinge. The necessity of providing the best type of education for engineers cannot be exaggerated. There is no education more important to the prosperity of the country, and it should be regularly inquired into and constantly revised to meet changing conditions. A lien between manufacturers and colleges exists, we are happy to say, in most districts. It does much good work. But some action on a larger scale, a national scale, is urgently needed. There are many problems to be faced. Even a Royal Commission would be none too great to do the matter justice, but there is no need to invoke such great powers; the major institutions could conduct an inquiry that would provide the information that is needed.

The Price of Coal.

ON Monday last the coal dispute ended in the manner which we had foreseen; that is to say, without a national agreement. Both parties have turned their backs upon the Government, yet it was Parliament which ended the struggle. When it passed the Eight Hours Bill early in July it made an Agreement impossible, and if, there and then,

the Cabinet had had the courage to defy public pressure and had refused to have anything more whatever to do with the dispute or the disputants, we should have been where we are now some months ago. Yet the prolongation of the struggle has had one salutary result. The Government and, we hope, the country knows now that the interference of the State in industrial disputes is a mistake. We may rest assured that the present Cabinet will think, not only twice, but many times before it is drawn into such affairs again. It has been said that this was not an industrial dispute, that it was a political manœuvre with a strong revolutionary tendency. If that is so the reasons why the Government should have kept out of it are doubly strong. Its interference was just what the revolutionaries wanted. Had it refused to be drawn in, the dispute could have been kept upon the industrial plane and would never have become political. We do not blame the Government for its action; rather do we blame those who regard Parliament as some phenomenal cross between a super-policeman and a High Court judge, and expect it to settle every difficulty. It is such people who force into politics matters which have no right to be there and do just what the advocates of nationalisation and communism desire. There are some things in connection with industry which the State may very profitably and very properly undertake, but in no circumstances should it involve itself in disputes between employers and employed save in so far as may be necessary to uphold the common laws of the land.

The seven months' struggle is over and the future is of more interest than the past. We have to set ourselves with all our energies to recover, as soon as possible, from the enormous harm that it has done. The first step must be the reduction in the price of coal. There is no reason at all why it should, for long, cost more now than it did in December last and several reasons why it should cost less. The mines as a whole are in a better position. Most of them have made satisfactory working agreements with their men and the miners have increased their output by more than the equivalent of the longer hours. Indifferent and unwilling labour has been weeded out and reorganisation is proceeding. The cost of transportation, approximately three farthings per ton-mile, is still too high, and the problem of the owners' wagon, which is the fruitful cause of much expense, has still to be solved; but if only a better spirit can be maintained in the industry we see little reason why the price of coal should not fall fairly rapidly to a figure which will do much to encourage the rapid revival of the engineering and all allied trades. The price of iron is the controlling factor in that revival and it hangs upon the price of coke. There are at present only five blast-furnaces in use, and we believe that at the time of writing none of the coke ovens have yet been relighted. Hard as it may seem to those who are hungering for iron and steel, we are convinced that the coke oven and blast-furnace owners cannot serve the country better than by refusing to move until the price of coal falls to a reasonable figure. In 1924 nearly nineteen million tons of coal, apart from that used in gasworks, were reduced to coke, of which approximately one-half was consumed in blast-furnaces. In the same year over two hundred and seventy million tons were raised in Great Britain. Three and a-half per cent. may not seem to be a serious proportion of the whole output, yet the loss of it would be ample to affect very materially the prosperity of the mines. "The quick return of the price of coal to, at least, pre-strike level," said Sir John Hunter a few days ago, "is an absolute necessity in order to bring into line the cost of the other elements which go to make up the cost of steel." If industries and even householders will refuse stoutly to buy at exalted prices we shall return quickly to reasonable figures and our engineering firms will be able once more to resume their course without reliance upon foreign sources of supply.

Indications of a revival are already to be seen. Many orders for ships have recently been placed in this country, and several very large contracts for engineering work abroad have been secured. It would be unsafe to prophesy that we are about to return to that period of prosperity which was opening when the coal stoppage began, but at any rate there are fairly good grounds for hope. A few firms have worked steadily all through the past seven months and a good many have full order books. Hence, despite the loss we have suffered and the gain which our rivals have enjoyed, the prospects which the coming year holds out are fairly bright. A steady but not too rapid revival is what we need. A boom is almost as much to be dreaded as a continuance of depression. It would assuredly have its repercussion and would be accompanied by that disturbance of markets which gives a fictitious appearance of prosperity. Fortunately, there is little reason to anticipate it. A steady improvement will follow a steady fall in prices of all engineering materials, but that can only be brought about by an initial reduction in the price of fuel. The Government is, as usual, being urged by some people to control prices. We trust it will do nothing of the kind. The country has the matter in its own hands. It has only to refuse to buy coals at exorbitant figures and the market will rapidly adjust itself. The owners have secured what they wanted, the permissive eight hours' day, and they should be in a position to sell coal at the pithead at a lower figure than that prevailing seven months ago. It needs but the persistent pressure of purchasers to effect that reduction which is essential to the real revival of industry.

Literature.

SHORT NOTICES.

Alternating Current Rectification. By L. B. W. Jolley. London: Chapman and Hall, Ltd. 2nd Edition. Price 30s.—Recent improvements in the design and manufacture of rectifiers had rendered an early revision of this book necessary. Whilst the general arrangement of the second edition remains unaltered, three new chapters on the installation of thermionic rectifiers, radio suppliers and inverters have been added. The second of these new chapters deals with apparatus for supplying the anode and filament current to valves from public supply mains, and although it is perhaps a little out of place in a book of this nature, there is no doubt that the information which the author supplies may prove of value to many who are engaged in the wireless business. Considerable attention is paid in this new edition to the transverter—a machine which up to the present does not appear to have made much headway in the electrical industry. The new chapter on the installation of thermionic, rectifiers adds materially to the value of the book, which we believe is still the only volume that deals exclusively with alternating-current rectification.

Electrical Characteristics of Transmission Circuits. By Westinghouse Engineers, compiled by William Nesbit, Westinghouse Technical Night School Press, East Pittsburg, Pa.—The third edition of this volume constitutes a slight revision plus a large addition to the original articles entitled "Electrical Characteristics of Transmission Circuits," originally published in the *Electric Journal*, and later in book form, by the Westinghouse Company. The principal additions consists of tables of auxiliary constants, a chapter on insulators, one on general circuit constants and circle diagrams, a chapter on stability of circuits, and another on tabulated data on existing lines. From time to time many articles pertaining to methods of solving transmission-circuit problems have been published, and this book constitutes a review of the methods that have been proposed by various authors. Examples are given for the purpose of illustrating each method of solution, and the reader is told what degree of accuracy each method is likely to provide. Great efforts have been made to simplify explanations with the aid of supplementary diagrams and cables.

Wireless Pictures and Television: A Practical Description of the Telegraphy of Pictures, Photographs, and Visual Images. By T. Thorne Baker. London: Constable and Co., Ltd. 1926. Price 6s. 6d.—In this little volume the author has collected together outlines of the various attempts which have been made to transmit illustrations telegraphically. Some of those attempts, as we know, have achieved a certain measure of success and are regularly employed for press work. That branch of the subject is relatively simple. Television, the electrical transmission of the vision of moving objects, is far more difficult, but a start has already been made, and the author is convinced that complete success will be achieved. The descriptions given are brief but effective, and leave no doubt upon the mind as to the principle of operation of the different devices employed.

BOOKS RECEIVED.

Engineering Science. By W. Ward. London: Edward Arnold and Co., 41, Maddox-street, W. Price 3s. net.

Marine Works. Second edition. By E. Latham. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, E.C. 4.

The Corrosion of Metals. Second edition. By Ulick R. Evans. London: Edward Arnold and Co., 41, Maddox-street, W. Price 15s. net.

The Whitworth Book. Honorary Editor, D. A. Low. London: Longmans, Green and Co., Ltd., 39, Paternoster-row, E.C. 4. Price 10s. 6d. net.

Bus Operating Practice. By R. Hauer and G. H. Scragg. London: The American Book Supply Company, Ltd., 149, Strand, W.C. 2. Price 12s. net.

The South American Handbook, 1927. Edited by J. A. Hunter. London: South American Publications, Ltd., Atlantic House, Moorgate, E.C. 2. Price 2s. 6d. net.

Der durchlaufende Träger über ungleichen Öffnungen. By Dr.-Ing. Emil Kammer. Berlin: Julius Springer, Linkstrasse 23-24, W.9, Germany. Price 25·50 marks.

Explosive Reactions in Gaseous Media: A General Discussion held by the Faraday Society. London: The Faraday Society, 90, Great Russell-street, W.C. 1. Price 10s. net.

Jane's Fighting Ships, 1926. Edited by Oscar Parkes and F. E. McMurtie. London: Sampson Low, Marston and Co., Ltd., 100, Southwark-street, S.E. 1. Price 42s. net.

The Calender Effect and the Shrinking Effect of Unvulcanised Rubber. By Dr. W. De Visser. London: Crosby, Lockwood and Son, 7, Stationers' Hall-court, E.C. 4. Price 15s. net.

Traction on Rails by Internal-combustion Engines and the Fieux Clutch for Motor Vehicles. By E. Brillié. Simla: Technical Section, Railway Board Office, India. Price 4s. 8d. net.

Die Kraftfelder in festen elastischen Körpern und ihre praktischen Anwendungen. By Dr.-Ing. Th. Wyss. Berlin: Julius Springer, Linkstrasse 23-24, W.9, Germany. Price 25·50 marks.

Manual of Electrical Undertakings and Directory of Officials, 1925-1926. Edited by T. C. Garrett. London: The Electrical Press, Ltd., 13-16, Fisher-street, W.C. 1. Price 35s. net.

Brassey's Naval and Shipping Annual, 1927. Edited by Sir Alexander Richardson and A. Hurd. London: W. Clowes and Sons, Ltd., 94, Jermyn-street, S.W. 1. Price 25s. net.

Annales des Ponts et Chaussées. 1926—V. Septembre-Octobre. Partie Technique, Tome II., Fasc. V., and Partie Administrative, Fasc. 5. Paris: A. Dumas, 6, Rue de la Chaussée d'Antin.

Practical Structural Design in Timber, Steel and Concrete. Third edition. By E. McCullough. New York: The Scientific Book Corporation, 15, East 26th-street, N.Y., U.S.A. Price $4·00 net.

American Society for Testing Materials Tentative Standards, 1926. Philadelphia: American Society for Testing Materials, 1315, Spruce-street, Pa., U.S.A. Price $7·50 unbound and $8·50 bound in cloth.

Description of the Planning, Progress, Costing and Engine Repair Schedule System introduced in the G.I.P. Railway Locomotive Shops at Parel. By F. G. S. Martin. Simla: Technicel Section, Railway Board Office, India. Price 2s. net.

SIXTY YEARS AGO.

SIXTY years ago, according to an article in our issue of November 30th, 1866, it was estimated that in Great Britain and Ireland there were in circulation about one hundred and fifty million sovereigns and six hundred and twenty million silver coins of all denominations. With the spread of travelling and the increased rapidity of trade the attrition suffered by the coins in the course of their life had reached considerable proportions. Each year, so it was stated, the replacement of the loss caused by attrition involved an expenditure of about twenty thousand pounds on the part of the public treasury. In the case of gold coins the attrition was allowed to proceed until the weight of the sovereign had become half a grain less than the minimum legal weight as originally issued. It could then be called in for re-minting, and the law had it that compensation for its deficiency could be demanded from its last holder. The enforcement of this compensation had some years previously been conducted with great rigour, and had led to an outcry against light gold. Silver and bronze coins being tokens of greater nominal than intrinsic value were allowed to suffer greater wear than gold before being called in. So long as the faintest impression of the dies remained on them they were permitted to circulate, with the result that they sometimes lost a third of their original weight before being withdrawn for re-minting. On the average a hundred old shillings would make only eighty new shillings. The wear suffered by silver coins, it was stated, depended upon their nominal value. In the course of three years' active life crown pieces would lose 5 per cent. of their original weight, half-crowns 10 per cent., shillings 30 per cent., sixpences 40 per cent., and threepences 42 per cent. The smaller coins being more actively circulated suffered the greater wear. In the case of bronze coins the smaller farthings changed hands less frequently, and consequently experienced less attrition than the larger pennies. Attention was called to the fact that the longevity of all coins was affected by the mode in which they were manufactured. The plain disc before being placed between the dies of the coining press was as plastic as it could be made. In the process of stamping certain portions of the surface were depressed, while others were allowed to remain at their original level. The depressed surfaces were hardened by the pressure and deformation, while the portions left standing remained in their original soft state. The hardness of the depressed portions was practically useless. The softness of the standing portions was objectionable, because it was just those portions which had to withstand the brunt of the attrition. We suggested that the consequent wear might be mitigated if all coins at their birth were formed with broad and deep projecting rims, which for a time, at any rate, would protect the obverse and reverse impressions from speedy defacement.

THE Dominion Water Power and Reclamation Service of the Department of the Interior of Canada has recently issued the annual report of its activities for the fiscal year ended March 31st, 1925, and the report just published—85 pages with eleven plates and four tables—describes the various administrative responsibilities of this service under three main divisions of activity, namely, water power, irrigation and drainage. Copies of this report will be supplied free of charge on application to the Natural Resources and Industrial Information Branch, Canadian Building, Trafalgar Square, London, S.W. 1, or to the Director of the Dominion Water Power and Reclamation Service, Ottawa, Canada.

An American Train-Ferry Steamer.

No. II.*

THE propelling machinery of the American train-ferry steamer, George H. Walker, of the Gulf Coast Railway, consists of two independent units arranged in the deck houses on either side of the track deck. Each unit consists of an engine and boilers, with the engine shaft geared to a short paddle-wheel shaft. Each engine is forward of the paddle-box, and forward of the engine-room again is the boiler-room, with two boilers served by a single funnel. These power units are necessarily independent, since the use of the deck for railway carriages and wagons prevents the use of a continuous paddle shaft and makes it necessary to place the engines on either side of the track deck.

Paddle-wheel Engines.—Each engine is of the two-cylinder simple non-condensing type, with opposed cylinders of 18in. diameter and 36in. stroke, inclined at an angle of 15 deg. from the horizontal. The two connecting-rods take on the same pin in a crank arm, which is formed with a counterweight projection. Each engine is rated at 600 indicated horse-power when running at 90 revolutions, taking steam at 200 lb. pressure and exhausting into a feed-water heater of the open type. A plan and elevations of one of the engines are given in Fig. 4, which shows also the gear connection. The relation of gearing to the engine and paddle shafts is shown also in Fig. 3 of the preceding article.

The cylinders are of cast iron, with the steam chests cast integrally with them; the pistons also are of cast iron, of the box section type. Piston-rods of forged steel are fitted to the pistons with taper and nut, and to the cast steel crossheads with taper and key. Cast iron crosshead guides are bolted directly to the structural steel girders of the engine frame. Connecting-rods of forged steel have a length of 7ft. 6in. between centres of pins, with bearings 5½in. long, of 8in. diameter for the crank pin and 6½in. diameter for the crosshead pin. Their ends are of the closed-end type, with semi-steel boxes, well babbitted. The crank end is fitted with taper wedge and bolts, while the crosshead end has taps, wedge and bolts. Valve gears of the Joy type operate the piston slide valves.

The steel crank pin, with a bearing 8in. in diameter and 11in. long, is fitted to a crank arm of forged steel 10in. thick and counterbalanced for the connecting-rods. This crank arm is shrunk on the 12in. pinion shaft, which is 6ft. 3in. long, with an inboard bearing 12in. by 22in. and outboard bearings of 12in. by 16in. Collars on the bearings hold the shaft in position.

Paddle wheels of the radial non-feathering type, 30ft. 6in. in diameter have nineteen wooden buckets or floats of oak, 3ft. wide and 14ft. long, each made with three pieces of 12in. plank. There are three rings or circles composed of ½in. bars 6in. wide, with arms of the same thickness but 11in. width, and built up with circle braces. These radial arms are attached to three cast steel flanges, 7½ft. in diameter, which are keyed to the wheel shaft. This shaft, of forged steel, is 14in. in diameter at one end, with an inboard bearing 14in. by 18in., and tapers to 11in. diameter at the outboard end, which has a bearing 11in. by 14in. On the inboard end is keyed a cast steel spur wheel having 113 cut teeth of 12in. face width and with a pitch of 1in. This gear engages the forged steel pinion on the engine shaft, which has 19 cut teeth of 12½in. face width.

Each engine is supplied with steam by a battery of two horizontal tubular boilers placed side by side, and forward of the engine-room. The piping is so arranged, however, that any one boiler can supply either of the engines. These four boilers are 6ft. in diameter and 18ft. long, each with a steam drum or dome 42in. in diameter and 42in. high. A heating surface of 1860 square feet is provided by ninety tubes of 2½in. diameter in the shell and 4in. water tubes between the water legs, which are connected by longitudinal tubes. Each boiler has an independent setting, with casing and firebrick complete. They are lagged with 2in. of magnesia, covered with heavy canvas. As oil fuel is used there are no grate bars, but bearers are provided to carry grate bars in case of a change to coal fuel. Each pair of boilers is connected by steel uptakes to a 49in. funnel, dampers being fitted for regulating the draught in each boiler.

For each battery of boilers there is a feed pump of the plunger type, with 10in. steam cylinder, 6in. water plunger and 12in. stroke, but the piping is arranged to enable either pump to serve any or all of the boilers. Each battery also has a tank pump with cylinders 7½in. by 10in. and 6in. by 10in. to deliver water from the cold well to a Cochrane feed-water heater with capacity for handling 18,000 lb. of water per hour, raising its temperature from 80 deg. to 210 deg. Fah. This heater discharges into a hot well of such capacity that a supply of feed water sufficient for 15 minutes can be heated while the boat is making its trip, and then pumped into the boilers while the boat is moored. The exhaust pipes from the main engines and auxiliaries are led to the feed-water heaters. Injectors draw from the cold well only, as do the tank pump and the fire pump. From each cold well a 12in. pipe leads to a sea-cock, fitted with a brass strainer plate and with a blow-off pipe for cleaning the strainer.

For the lighting equipment, there is a 10-kilowatt turbine-driven generator furnishing 110-volt continuous current for interior lights, for lights suspended over the track deck from the transverse hog rods, and for a powerful headlight on top of the pilot house. This headlight is controlled from the interior of the pilot house.

Landing Cradle and Incline.—An example of the type of landing cradle used with train-ferry steamers of this kind, on rivers having great and continual changes in water level, is shown in Fig. 5. The travelling cradle itself runs on an inclined track the rails of which may be partly on sleepers laid on the earth of the river bank and partly on a timber trestle. On the upper part of the incline are the rails on which cars run down to the cradle. In this trestle construction, rows of piles are driven about 15ft. apart, each row being capped with a heavy transverse timber and braced by diagonal planks. Longitudinal struts may also be placed along the outer piles, as well as longitudinal diagonal bracing in occasional panels or bays where the trestle is high or of considerable length. Upon the caps are laid longitudinal girders or stringers, each composed of three timbers on edge and bolted together, but with separators or spacing blocks between them to allow of air circulation to prevent decay. Across these are laid the sleepers.

For convenience in bringing the steamer in and out of its berth, the incline is laid usually diagonally down the bank in a downstream direction. A line of fender piling on one or both sides of the incline serves to protect the vessel from the current as it moves in and out of its berth, and also serves to hold it in position when moored with its bow against the end of the landing cradle.

The cradle—shown in Fig. 5—is about 160ft. in length, in addition to the 15ft. feather-edge rails, which are bolted to the cradle rails and ride on the rails of the incline. A 33ft. plate-girder apron at the lower end, and projecting partly beyond the cradle frame, makes a total length of about 190ft. over all. Two lines of timbers, 10in. by 14in., form the underframe, these sills or longitudinals being connected by transverse tie-rods, with cross struts and diagonal bracing between the timbers. This frame is mounted on a number of axles with 24in. flanged wheels riding on the rails of the incline, which has a gradient of 3½ per cent., or 1 in 28. At the upper end, however, the frame is dropped to meet the incline, and, as there is no room for wheels, the frame has on the bottom several cross timbers shod with iron which ride on the incline rails.

For the deck, or floor, which has an upward gradient

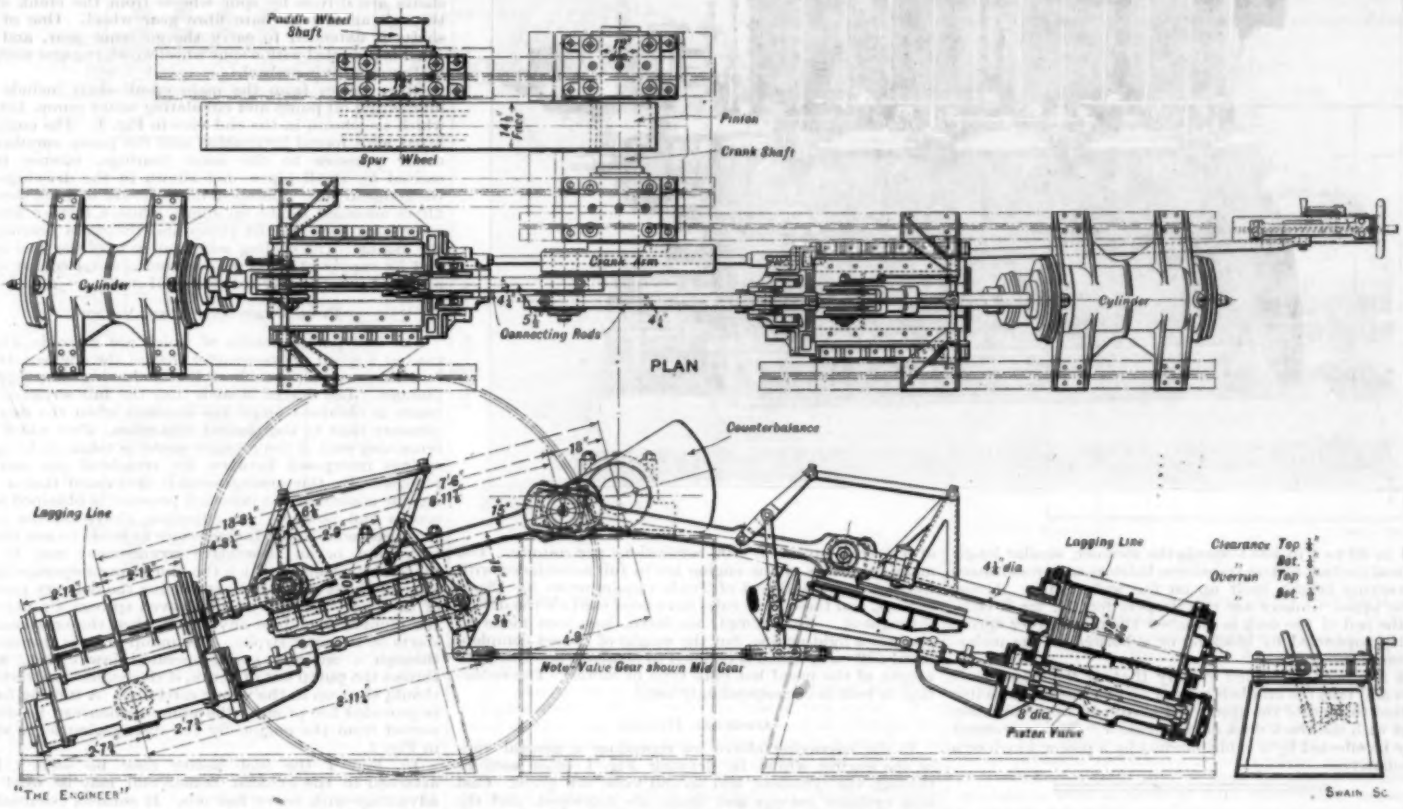


FIG. 4—ONE OF THE 600 I.H.P. PADDLE-WHEEL ENGINES OF THE "GEORGE H. WALKER"

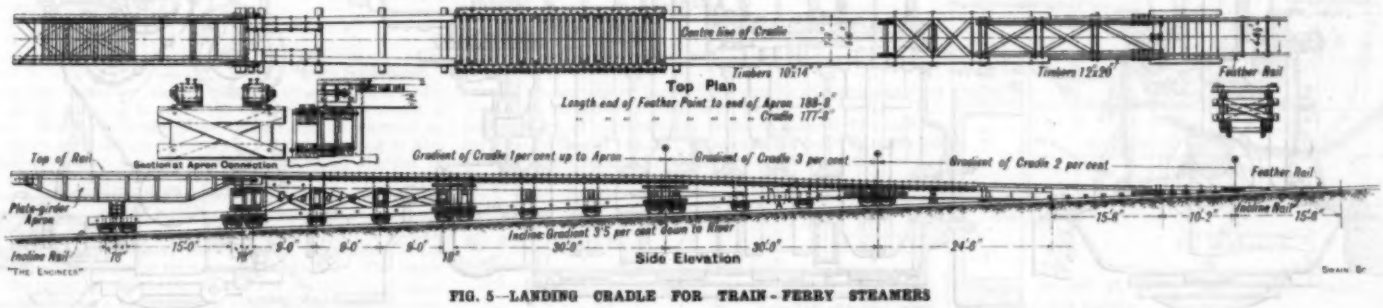
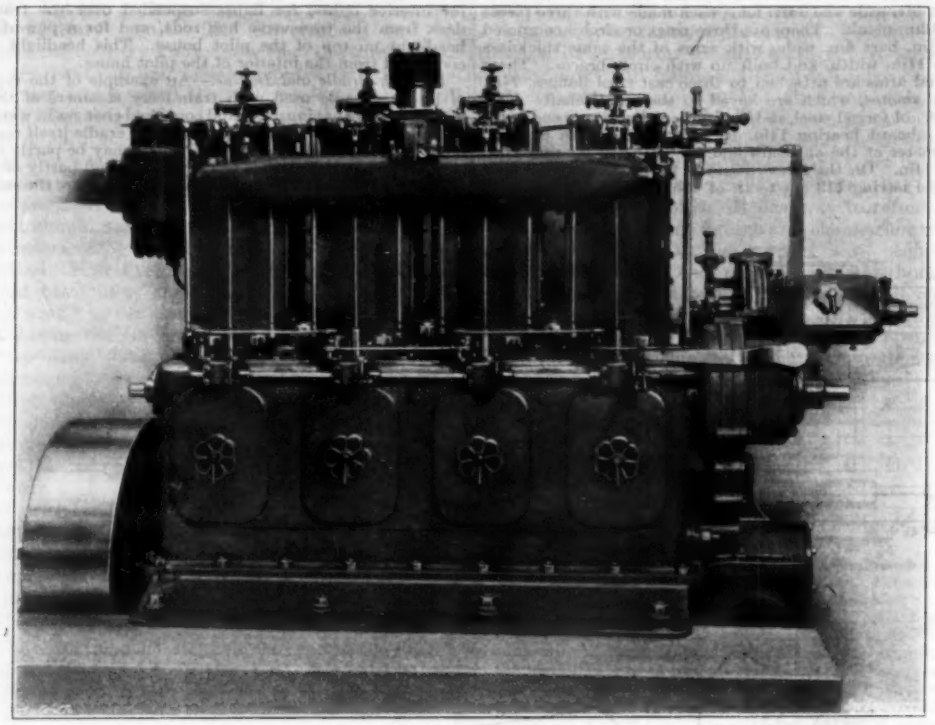


FIG. 5—LANDING CRADLE FOR TRAIN-FERRY STEAMERS

* No. I. appeared November 26th.

120 B.H.P. HIGH-SPEED OIL ENGINE

A. G. MUMFORD, LTD., COLCHESTER, ENGINEERS



of 1 in 30 to 1 in 100 towards the steamer, similar longitudinal timbers rest on transverse bolsters and cross frames of varying height, built up on the underframe. Across these upper timbers are the sleepers for the track rails. At the end of the deck is attached the plate girder apron, partly supported by blocking or a bolster on the underframe of the cradle.

It has been explained already that as the water level rises and falls the cradle is moved up and down the incline so that the end of the apron will always be approximately level with the track deck of the steamer. This movement may be effected by a cable handled by a power winch or a locomotive.

A New High-Speed Oil Engine.

THERE is no doubt that a large field of application, both marine and industrial, awaits the high-speed oil engine which is capable of using a wide range of fuels and of developing large power for its size and weight. In the present article an account is given of a new type of oil engine designed to fulfil these conditions, which has been built by A. G. Mumford, Ltd., of Colchester, under the Mumford and Boothroyd patents. The engine has been tested by Mr. W. A. Tookey, of Westminster, and appended to this article we give Mr. Tookey's report in full.

The engine is of the medium compression airless injection type, the fuel being mechanically injected into the cylinder by a timed valve at practically a constant pressure. It was designed primarily for marine purposes, and the size of cylinder chosen follows the firm's standard practice for Mumford's paraffin engines, which have for many years been used with success in Admiralty motor boats. The four cylinders have each a diameter of 5½in., with a stroke of 9in., and the unit is designed for a maximum rated output of 120 brake horse-power, when running at a normal speed of 1100 revolutions per minute. The main scantlings of the engine are in full accordance with Lloyds' and the Board of Trade requirements for Diesel engines, and these same rules have been used for the design throughout. No attempt, we learn, has been made to produce a light engine, but the weight of the set complete is only 30 cwt., which is claimed to be about one-third the weight of the usual hot-bulb type of motor. The reduction in bulk is correspondingly large.

GENERAL DESIGN.

In the engraving above we reproduce a general view of the engine, whilst in drawing Fig. 1 cross sections through the cylinders, and an end view, are given. Cast iron cylinder casings and liners are employed, and the crank case and bed-plate with its removable oil sump are made of this same metal. It will be seen that the bed-plate is of the box pattern, and it carries the supports for the main bearings. The crank shaft is provided with balanced webs and is drilled for lubrication. It runs in turned gun-metal bearings lined with white metal. In designing the bearing provision has been made for the removal and the examination of the bearing shells without having to disturb the crank shaft or the crank casing. A big-end bearing similar in type to the main bearing is employed, and is secured to the palm end of the hollow connecting-rod by four fitted bolts. The pistons are made of cast iron and are provided with four narrow rings at the head and one scraper ring in the skirt. A hollow gudgeon pin of large diameter is used. Turning to the cylinder covers—see Fig. 1—it will be seen that there are two inlet and two exhaust valves to each cylinder. The exhaust valves are water cooled. All valves are housed in detachable cages and are operated by rocking levers and push-rods from two cam shafts arranged in the top corners of the crank casing. Cast iron valve heads of special construction are used, a ring being cut on the shank of the valve head, which in the event of a valve stem snapping engages with a projecting screw and prevents the head from falling into the working cylinder. A central fuel valve is fitted and will be described later. Although the cylinders have no separate head, the valves can easily be dismantled for inspection, and the piston and connecting-rod can be lowered through one of the large inspection doors which are fitted one at either side of the crank chamber.

The two cam shafts are carried in bearings arranged in the crank case webs and are stiffly constructed. The exhaust cam shaft is furnished with four sliding cams, which allow half compression to be used when starting up. In addition to the inlet cams the inlet cam shaft carries four fuel cams, which can be moved on helical keys, thereby altering the timing of the fuel injection. Weak springs are fitted on both inlet and exhaust tappets, so that any tendency to chatter is obviated.

As will be seen from drawing Fig. 1 the two cam shafts are driven by spur wheels from the crank shaft through an intermediate fibre gear wheel. One of the shafts is extended to carry the governor gear, and the other is provided with a spur wheel which engages with the fuel pump driving wheel.

Other drives from the main crank shaft include the lubricating oil pump and circulating water pump, both of which are shown in the end view in Fig. 1. The engine is fitted with forced lubrication and the pump supplies oil under pressure to the main bearings, whence it is carried by small pipes—not shown in the drawings—to the gudgeon pins. The spent oil is allowed to drain through filters arranged in the oil sump, while a further filter is interposed between the pump and the main bearings of the engine. The cooling water pump is of the gear type, and its supply of oil is drawn from a water-cooled space arranged immediately below the oil sump.

FUEL PUMP AND FUEL VALVES.

The fuel pump, details of which are given in Fig. 2, runs at a speed of one-quarter that of the engine. It is a four-throw pump, each cylinder having its separate plunger. The design is such that the full stroke of the pump is obtained up to the moment when the delivery pressure rises to the desired maximum, after which any remaining part of the plunger stroke is taken up by spiral springs interposed between the crosshead pin and the plunger. By this arrangement it is claimed that a very regular control of the injection pressure is obtained at all speeds and powers. An adjusting sleeve on the pump crosshead enables the fuel pressure to be set to any desired maximum, or an alternative arrangement may be employed by means of which the four plunger springs can be altered whilst running, thus varying the delivery pressure of the fuel. A series of interleaved springs are fitted on the plunger to reduce any shock when the crosshead restarts on its outer stroke. The pump drive is transmitted through a one-way spring-operated jaw clutch, which throws the pump out of action if the engine inadvertently should start up in the wrong direction. A turning handle is provided for priming the pump, which can be disconnected from the engine by the disengaging lever shown in Fig. 2.

In Fig. 1 the fuel heater may be seen. It is attached to the exhaust branch and may be used with advantage with heavy fuel oils. It consists essentially of coils of heated tubing through which the fuel is made to pass on its way to the fuel valves. The coils are grouped in a chamber heated by the exhaust gases, but are not actually in contact with them. Ventilating sleeves are provided, so that the oil can be heated to any desired temperature, and its viscosity be reduced. Between each fuel pump and the corresponding fuel valve a stop valve is fitted, so that fuel can be cut off from any cylinder.

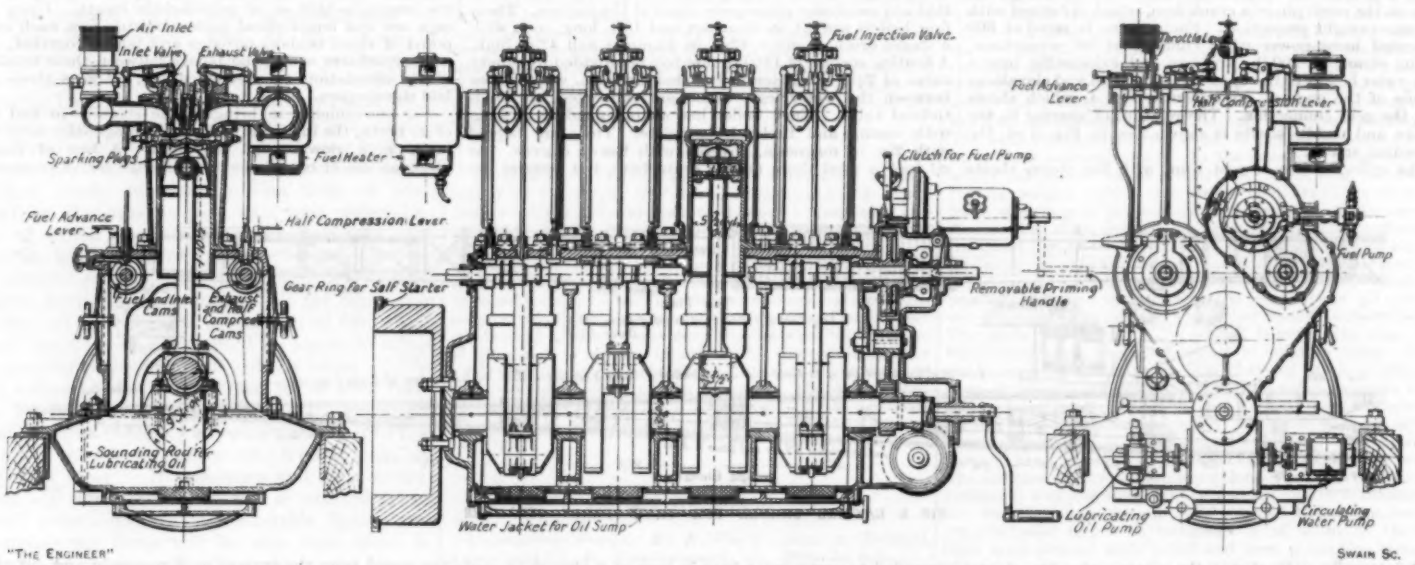


FIG. 1—HIGH-SPEED OIL ENGINE—SECTIONS AND END VIEW

In the lower part of Fig. 2 a longitudinal and cross section of one of the fuel valves is given. The construction shown is the subject of several patents. The valve is normally retained on its seat by the internal spring, which is assisted by the pressure of the fuel. It is lifted from its seat by means of a rocking cross shaft, which transmits its motion to the fuel valve needle through rods fitted with ball joints. All parts of the valve have been designed for high-speed running and are very light. Experiments have shown that as far as the fuel valve is concerned there is no reasonable limit to the economical speed of the engine. A valuable feature of the design is the provision made for slightly turning the fuel valve upon its seat whilst the engine is running. This is done by a hand wheel at the top of the valve, and by this means a good and even seating

is always maintained. From the drawings given it will be seen that a special form of stirrup is fixed to each end of the horizontal rocking shaft and an adjustable stop is provided to limit the movement of the stirrup. Means are also provided for the accurate setting of the connecting-rod which is attached to the stirrup. The four valves can thus be quickly tuned, use being made of an indicating pointer attached to the stirrup, which enables the valve lift to be regulated to within one-thousandth of an inch.

STARTING AND RUNNING CONTROLS.

The engine may be run up by an electrically-operated self-starter consisting of a starting motor and a 12-volt battery. A special, and in some respects novel, system of electric ignition is employed. The two sparking plugs, which are placed opposite one another in the combustion space, are arranged so that the electrodes can be made incandescent although the ordinary spark gap is used on high-tension current. The current is switched on about twenty seconds before starting up, and with this provision the engine starts instantly from cold on paraffin fuel. It is claimed that only a very small amount of current is required by this system. The plugs can also be put into service for stand-by timed ignition when exceptionally slow speed running is required, when still less current is taken. When the engine has started and is warmed up the heavy fuel can be turned on. Hand starting is also provided if called for and the engine is easily started in that manner.

The system of running controls is quite a special feature of the engine. At the right-hand of the engine—see end-view Fig. 1—will be seen the three control levers. One horizontal lever, that nearest the centre of the engine, is for the half compression starting position alone. The other two, the outer horizontal lever and the vertical lever, may be said to replace the ordinary throttle and ignition controls of a motor car and they function in a similar manner. The vertical lever varies the lift of the fuel valve and the opening of the air throttle, whilst the horizontal lever advances or retards the fuel injection, and its position is altered in accordance with the speed and the special conditions under which the engine is running. A centrifugal governor is provided, which in the case of a marine engine would only come into action when the clutch between the engine and the propeller shaft was thrown out of action. Otherwise all speed control would be by hand. The characteristics of the engine and its performance are dealt with in the trials report which follows. It may be of interest to state that the good results as regards flexibility, fuel consumption, and wide fuel range, are a repetition of the performance obtained with a single cylinder 4in. bore experimental engine, which was built and run by the firm prior to the present engine. This model had a cylinder, connecting-rod and other details of exactly similar pattern to those used in the firm's light type paraffin engines, and after prolonged running no defects were evident, although the engine developed 36 per cent. more power than a paraffin engine of similar dimensions and speed.

REPORT AND TRIALS MADE BY MR. W. A. TOOKEY, FEBRUARY, 1926.

To A. G. Mumford, Ltd.,
Culver-street Engineering Works, Colchester.

GENTLEMEN,—In accordance with your instructions I made several visits to your works during the present month for the purpose of making an extensive series of tests upon the liquid-fuel engine constructed under the Mumford and Boothroyd patents. In all upwards of fifty trials have been completed, and upon these I report as follows :—

(1) *Description of Engine.*—The engine tested is a four-cylinder unit operating upon the four-stroke cycle. It is rated at 120 horse-power maximum output at 1100 revolutions per minute. The fuel is mechanically injected at or about the end of the compression stroke, and, therefore, differing materially in design from the ordinary paraffin or petrol engine, in which the charge is admitted during the induction stroke and the mixture afterwards compressed ; a variety of liquid fuels can be utilised, enabling the engine to be serviceable in all parts of the world. The temperature of compression—volume ratio 8·74—suffices for the ignition of the fuel without a hot bulb or uncooled metallic surface, and in consequence the operation of the engine is entirely free from the phenomena peculiar to what are commonly called "semi-Diesel" engines.

Fuel injection timing and duration is controlled by a simple lever and notch quadrant, and this combined with similar throttle control of the air admitted to the cylinder provides an extraordinary range of elasticity and complete adaptability to varying fuel characteristics. The total weight is about 30 lb. per rated horse-power.

(2) *Objects of the Trials.*

(*a*) To test the engine with three brands of liquid fuels readily obtainable in most parts of the world, viz., paraffin or kerosene ; Gasoleum or gas oil ; and Diesoleum or Diesel oil.

(*b*) To measure the brake horse-power developed and fuel consumed at full load when running at speeds varying from 750 to 1300 revolutions per minute.

(*c*) To determine the power obtained and fuel consumed at various positions of the throttle control at uniform speeds.

(*d*) To note the extent of practical speed control under conditions simulating propeller thrust as in motor boat service, and response to throttle changes, both gradual and sudden.

(*e*) To record the actual thermal efficiencies attained under all conditions.

(*f*) To report upon the general performance of mechanical details and the condition of internal parts after the whole series of tests.

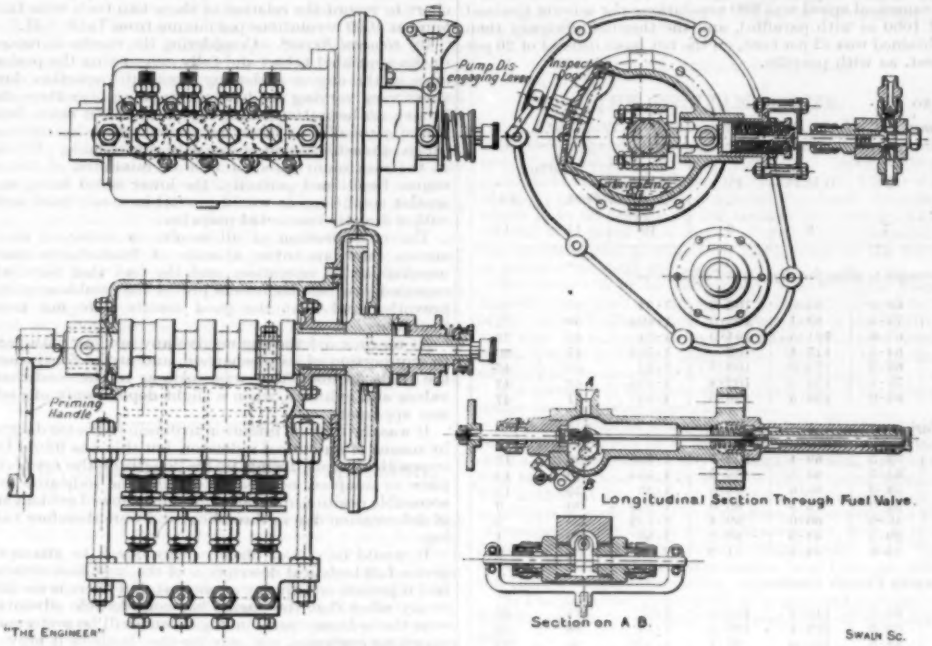


FIG. 2—FUEL PUMP AND FUEL VALVE

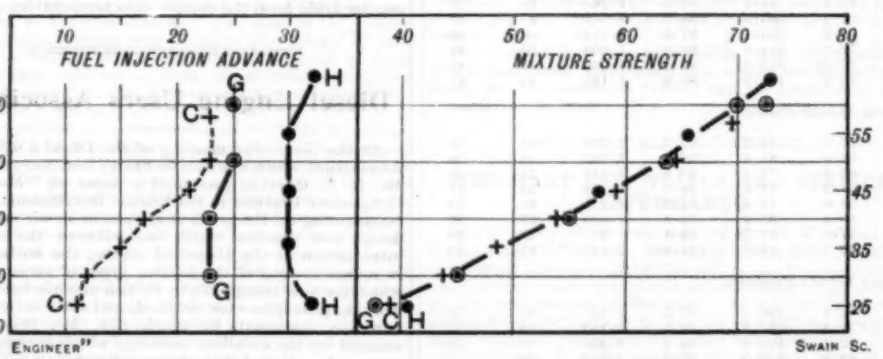


FIG. 3

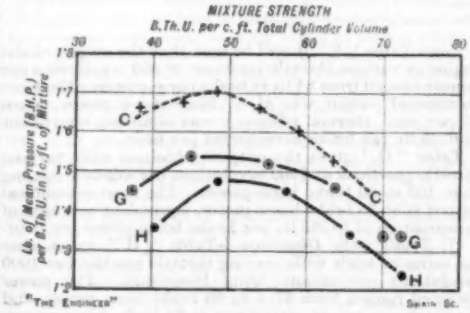

MIXTURE STRENGTH
B.Th.U. per c. ft. Total Cylinder Volume
Lb. of Mean Pressure (B.H.P.) per B.Th.U. in 1 c. ft. of Mixture
"THE ENGINEER"
SWAIN SC.

FIG. 4

(3) *Testing Arrangements.*—For the purposes of the tests a standard type of Heenan and Froude water dynamometer—a description of which is unnecessary in this report—was directly coupled to the engine The usual measuring tanks for two kinds of fuel were provided, and all tests were made by noting the time to the nearest second in which 2 lb. weight of fuel were consumed. During the timed period a special revolution counter was put into and withdrawn from gear so that the actual number of revolutions were ascertained with considerable accuracy, a tachometer being used during the rearrangement of loads, &c., as a general speed indicator. Certain tests were repeated, with but one second difference, showing that the observational error was practically negligible.

(4) *Fuels.*—The physical characteristics of the fuels used were :—

(*a*) Paraffin (kerosene), "White May" brand, of the British Petroleum Company, Ltd. Specific gravity at 60 deg. Fah., ·804 ; initial boiling point, 152 deg. Cent.; final boiling point, 307 deg. Cent.; flash point, 140 deg. Fah.; sulphur, 0·02 per cent.; gross calorific value, 20,000 B.Th.U.; net calorific value, 18,600 B.Th.U. per pound.

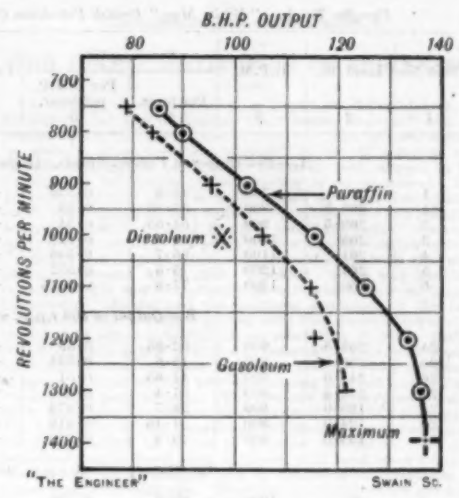


FIG. 5

(*b*) Gasoleum (British Petroleum Company, Ltd.). S.G. at 60 deg. Fah. ·863 ; flash point, 204 deg. Fah.; carbon residue, 0·10 per cent.; viscosity, Redwood I., at 70 deg. Fah., 51 sec.; viscosity, Redwood I., 100 deg. Fah., 41 sec.; calorific value (gross), 19,650 B.Th.U. per pound ; (net), 18,350 B.Th.U. per pound ; asphalt, 0·05 per cent.; sulphur, 0·33 per cent.

(*c*) Diesoleum (British Petroleum Company, Ltd.). S.G. at 60 deg. Fah., ·895 ; flash point, 186 deg. Fah.; viscosity at 30 deg. Fah., 110 sec.; sulphur, 0·1 per cent.; coke, 3 per cent.; ash, 0·06 per cent.; calorific value (gross), 19,332 B.Th.U. per pound ; (net), 18,000 B.Th.U. per pound.

(5) *Trials with Paraffin.*—Tables "A," "B," and "C" and "D" appended to this report summarise the principal figures relating to the trials made with paraffin as fuel, and the accompanying charts, Figs. 3, 4, 5, and 6, show the relation of the various tests in the several series.

The series "A" were at varying speeds from 750 to 1300 revolutions per minute, and in order that the results may

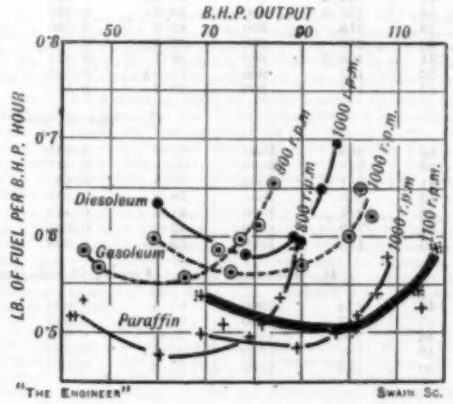


FIG. 6

be more readily comparable the figures tabulated have been corrected to allow for the actual speed differences slightly above and below the tabulated speeds.

It will be seen from Column 8 that the brake horse-power obtained with paraffin ranged from 85 at 750 to 135·5 at 1300 revolutions per minute, and at 1400 revolutions per minute a maximum of 138·5 brake horse-power was developed. This point, as will be seen from Chart 3, Fig. 5, appended, follows the natural extension of the curve through the plotted points.

From Column 6 it will be appreciated that the thermal efficiency on the brake horse-power basis was entirely satisfactory at all outputs. The most economical speed was 1000 revolutions per minute, when the thermal efficiency obtained was practically 26 per cent.; while at the minimum and maximum speeds tabulated the thermal efficiency was but slightly affected—a tribute to the effective control permitted by the design.

Expressed in pounds of fuel per brake horse-power hour, the rate of consumption at full output at 1000 revolutions per minute was 0·526, as noted in Column 5.

From Column 9 it will be observed that the highest mean pressure on the brake horse-power basis was attained at the slowest speed there tabulated, but in fact, as the figures show, the pressure was well maintained up to 1200 revolutions per minute and was affected to the extent of only 6 per cent. at 1300 revolutions per minute.

Table "B" reproduces the principal figures obtained with the engine running on paraffin at 800 revolutions per minute, and with varying positions of the throttle, the advancement of fuel injection being suitably adjusted. The brake horse-power output varied from practically 90 brake horse-power at notch 50 to half this power at notch 20. From Column 5 it will be seen that the rate of fuel consumption was extremely good and at 60 brake horse-power fell to 0·48 lb. per brake horse-power per hour, representing a thermal efficiency of 28·5 per cent.

In Table "C" similar figures are given when the engine was running on paraffin at 1000 revolutions per minute, and, as will be noted, the highest efficiency was obtained at about 90 brake horse-power output, when the consumption was again 0·48 lb. per brake horse-power hour, or 28·5 per cent. thermal efficiency.

In Table "D" the tests made on paraffin at 1100 revolutions per minute show that the lowest consumption was reached at 100 brake horse-power output with 0·50 lb. per brake horse-power hour and a thermal efficiency of 27 per cent.

(6) *Trials with Gasoleum.*—In Table "E" is given various outputs attained with gasoleum at various speeds and comparable with Table "A" for paraffin. It will be noted that the brake horse-power developed ranged from 80 to 120 brake horse-power at 750 and 1300 revolutions per minute respectively.

From Column 9 it will be noted that the mean pressure on the brake horse-power basis remained practically constant between 750 and 1100 revolutions per minute, and was reduced by about 10 per cent. at 1300. The most economical speed was 900 revolutions per minute (instead of 1000 as with paraffin), and the thermal efficiency then obtained was 22 per cent. on the net basis instead of 26 per cent. as with paraffin.

TABLES A. TO H.

Paraffin Trials.—*"White May," British Petroleum Company, Ltd.* 20,000 *B.Th.U. gross*, 18,700 *B.Th.U. net.*

Test No.	Load, lb.	R.P.M.	Consumption. Per hour.	Consumption. Per B.H.P. per hour.	En net.	Qt.	B.H.P.	Pn.	Tn.	Settings. Fuel.	Settings. Adv.
1	2	3	4	5	6	7	8	9	10	11	12
A.—*Full Output at Various Speeds.* (*Figures corrected to allow for slight speed differences.*)											
1	272	750	45·8	0·539	·251	68·2	85·0	105·0	1·54	40	10
24	268·5	800	52·85	0·59	·231	73·5	89·4	103·5	1·405	50	13
2	269·5	900	54·55	0·54	·251	67·6	101·5	104·0	1·54	45	33
3	265	1000	60·5	0·526	·259	64·5	115·4	102	1·583	47	40
4	261	1100	66·7	0·546	·249	66·3	122·0	100·6	1·52	52	47
5	267	1200	73·5	0·572	·238	70·7	133·5	102·8	1·455	52	47
6	250	1300	73·6	0·5425	·250	63·0	135·5	96·5	1·53	41	47
B.—*Output at 800 r.p.m. with Varying Throttle Positions.*											
24	268·5	800	52·85	0·59	·23	73·5	89·4	103·5	1·406	50	13
25	256·5	800	45·6	0·534	·255	63·5	85·5	98·8	1·555	40	13
26	245·0	800	41·65	0·51	·266	58·0	81·6	94·5	1·63	35	11
27	220·5	800	37·4	0·509	·267	52·0	73·5	85·0	1·635	30	9
28	180·0	800	28·7	0·478	·284	40·0	60·0	69·4	1·738	25	5
29	124·0	800	21·45	0·519	·262	29·5	41·3	47·2	1·60	20	1
30	133·0	800	23·8	0·535	·253	33·0	44·35	51·2	1·55	20	0
C.—*Output at 1000 r.p.m. with Varying Throttle Positions.*											
3	265	1000	60·6	0·526	·257	65·0	115·4	102·0	1·57	47	40
33	260	1000	62·6	0·577	·236	69·4	108·4	100·0	1·44	58	23
34	253	1000	57·4	0·544	·25	64·0	105·6	97·7	1·525	50	23
35	244	1000	52·8	0·519	·262	58·8	101·5	94·1	1·60	45	21
36	233	1000	48·6	0·50	·272	54·0	97·0	89·8	1·66	40	17
37	215	1000	43·6	0·4865	·279	48·6	89·6	83·0	1·705	35	15
38	190	1000	39·3	0·497	·274	44·0	79·2	73·2	1·67	30	12
39	166	1000	34·5	0·499	·273	38·5	69·1	64·0	1·66	25	11
D.—*Output at 1100 r.p.m. with Varying Throttle Positions.*											
4	261	1100	66·7	0·546	·249	66·3	122·0	100·6	1·52	52	47
8	217	1100	50·1	0·503	·271	50·7	99·6	83·8	1·65	29	34
9	151	1100	37·5	0·541	·251	38·0	69·2	58·2	1·535	17	25
31	257	1100	69·9	0·592	·23	70·9	118·0	99·4	1·4	60	28
32	249	1100	62·3	0·546	·249	58·8	114·0	95·9	1·52	50	
E.—*Gasoleum Trials. Varying Speed.* 19,650 *B.Th.U. Gross*, 18,350 *B.Th.U. Net.*											
10	253	750	52·4	0·662	·209	76·5	79·0	97·5	1·275	42	18
11	253	800	55·1	0·654	·212	75·2	84·3	97·5	1·295	45	28
13	254	900	59·9	0·6285	·220	72·9	95·3	98·0	1·344	47	32
14	253	1000	67·9	0·644	·215	74·2	105·4	97·5	1·3125	50	38
15	250	1100	76·8	0·668	·2075	76·2	114·6	96·5	1·266	50	45
16	231	1200	79·6	0·668	·2075	70·25	115·5	89·0	1·266	45	47
17	224·5	1300	87·0	0·715	·194	73·0	121·5	86·5	1·185	45	47
F.—*Constant Speed. Varying Throttle Positions.*											
11	253	800	55·1	0·654	·212	75·2	84·3	97·5	1·295	45	28
12	244·5	800	49·85	0·612	·2264	68·0	81·4	94·0	1·383	40	28
18	232·5	800	36·2	0·597	·232	63·2	77·4	83·6	1·416	35	28
19	218	800	42·6	0·586	·2365	58·2	72·6	84·0	1·444	30	27
20	219	800	42·5	0·584	·2375	58·0	72·8	84·2	1·45	30	25
21	195·5	800	36·1	0·554	·25	49·4	65·2	75·5	1·526	25	20
22	143	800	27·65	0·568	·244	37·0	47·75	55·1	1·49	15	20
23	134	800	26·2	0·585	·237	35·7	44·7	51·65	1·447	15	20
G.—*Constant Speed. Varying Throttle Positions.*											
13	253	1000	67·9	0·644	·215	72·1	105·2	97·5	1·35	50	38
40	245	1000	66·2	0·647	·214	70·4	102·2	94·6	1·343	60	23
41	251	1000	61·9	0·65	·213	72·4	104·5	96·8	1·337	60	25
42	240	1000	59·8	0·597	·232	63·8	100·0	92·9	1·456	50	25
43	217	1000	51·5	0·571	·2425	55·0	90·3	83·7	1·521	40	23
44	179	1000	42·2	0·565	·245	45·0	74·6	69·2	1·538	30	23
45	142	1000	35·35	0·598	·2315	37·6	59·1	54·7	1·455	25	23
H.—*Diesoleum Trials. Varying Throttle Positions.* 19,332 *B.Th.U. Gross*, 18,000 *B.Th.U. Net.*											
46	234	1000	67·5	0·694	·204	72·4	97·4	90·2	1·245	65	32
47	227	1000	61·2	0·647	·219	65·4	94·6	87·5	1·338	55	30
48	216	1000	53·6	0·596	·2375	57·4	89·9	83·3	1·45	45	30
49	187	1000	45·35	0·582	·243	48·4	77·8	72·0	1·485	35	30
50	143	1000	37·8	0·634	·223	40·4	59·6	55·0	1·362	25	32

From Table "F" it will be seen that the output of the engine at various throttle positions at 800 revolutions per minute ranged from 84 to 44 brake horse-power. The most economical output was at 65 brake horse-power, when 25 per cent. thermal efficiency was obtained, equivalent to 0·55 lb. per brake horse-power per hour.

Table "G" gives the outputs obtained with varying throttle positions at 1000 revolutions per minute, ranging from 105 to 60 brake horse-power. The most economical output is at 75 brake horse-power, equivalent to a rate of consumption of 0·565 lb. per brake horse-power per hour.

(7) *Trials with Diesoleum.*—Table "H" summarises the series of trials with varying throttle positions at 1000 revolutions per minute using Diesoleum. The power obtained ranged from 97·5 to 60 brake horse-power, and the most economical output was at 78 brake horse-power, when thermal efficiency 24·3 per cent. was obtained, equivalent to 0·58 lb. per brake horse-power per hour.

(8) *Comparison of Results with Different Fuels.*—Comparing the results of trials "C," "G," and "H," all made at 1000 revolutions per minute with varying throttle positions, but with paraffin, gasoleum, and Diesoleum respectively, some useful comparisons present themselves. First, it will be noted from Chart 1—Fig. 3—that for the varying throttle positions recorded for tests "C," "G," and "H" in Columns 11 and 12, practically equivalent mixture strength was obtained irrespective of the fuel used, but it will be noted that considerable change of position of the injection advance lever was necessitated to accord with the physical characteristics of the three fuels. The efficiency of the special feature of fuel injection control is thus amply demonstrated.

Chart 2—Fig. 4—shows the effect of the characteristics of the fuel upon the mean pressure developed per heat unit in the mixture strength for the three trials "C," "G," and "H."

Chart 3—Fig. 5—shows graphically the outputs at various speeds for paraffin and gasoleum plotted from Tables "A" and "E." A point is also placed on this chart to record the relation of these two fuels with Diesoleum at 1000 revolutions per minute from Table "H."

(9) *General Report.*—Considering the results as recorded in the appended tables and fully considering the performance of the engine under my personal inspection during those very varying conditions extending over three days, I have no hesitation in saying that I have never before tested a paraffin or heavy-oil engine which has the same range of elasticity and is so easily controllable. Whether at the maximum speed of 1400 or minimum of 400, the engine functioned perfectly, the lower speed being under similar conditions as would prevail in motor boat service with a directly connected propeller.

The co-ordination of all results as indicated on the curves show an entire absence of freakishness and of unreliability in operation, and the fact that tests when repeated gave similar results proves that stable conditions prevailed and that the good results were not merely fortuitous.

At no time did the engine give any anxiety with regard to any portion of its mechanism, and at the conclusion of the trials an inspection was made as to the condition of valves and cylinder, when a slight deposit only of carbon was apparent.

It was the original intention to obtain indicator diagrams by means of an optical indicator, but this was found to be impracticable, as, owing to the length of the connecting piece or adapter, necessary to bring the indicator to an accessible position, diagrams obtained showed evident signs of deformation due to throttling, and were therefore valueless.

It would be out of place in this report to attempt to give a full technical description of the ingenious details of fuel injection and timing apparatus, but there is no doubt in my mind that the engine has considerable advantages over the ordinary paraffin engine and will be preferred by operating engineers, not only for the elasticity it provides, but for the manner in which all difficulties connected with vaporisation, &c., have been circumvented, giving also a cleaner engine and one of a higher thermal efficiency.

Chart 4—Fig. 6—gives the fuel consumption of the engine at various outputs and for different speeds of revolution.

Starting during the trials was by means of an electrical device—as on the modern car engine. The cylinders were fitted with sparking plugs, and by a simple knife switch current was passed through the points to cause incandescence for a few seconds before the button operating the starter switch was pushed. Of this detail also a practical engineer would thoroughly approve. The sparking plugs acted as igniters for one or two minutes until the internal temperatures had become sufficient to ensure regular firing from the compression temperature only.

Diesel Engine Users Association.

AT the November meeting of the Diesel Engine Users Association, which was held on Friday last, November 26th, Mr. R. L. Quertier presented a paper on "Modern Air Compressor Practice in Oil Engine Installations." After commenting on the great development in air compressor design and practice which has followed the successful introduction of the Diesel oil engine, the author passed in review several of the leading types of air compressors which are now being built by British manufacturers. The working principles were outlined, and some details of construction discussed, in which task Mr. Quertier was assisted by the excellent drawings which accompany the paper. A section of the paper was devoted to a description of the latest type of Reavell three-stage quadruplex compressor. The author pointed out the advantages conferred by this new design with its open type pipe connections and accessible air coolers, and also alluded to higher efficiency which has been obtained by the adoption of twin low-pressure cylinders with mechanically-operated suction valves in the form of ported gudgeon pins. An instance of the application of such a compressor was given in the set supplied for a Fraser and Chalmers-G.E.C. 1000-1125 brake horse-power, 750-kilowatt oil engine generator unit. On the official tests of this machine, at full load output, it was found that the power required to drive the compressor was just under 10* per cent. of the brake horse-power developed and 7·5 per cent. of the indicated horse-power.

In the second part of the paper the author dealt with some points in compressor design, and by the aid of indicator diagrams he showed the frictional, thermal, valve, volumetric and leakage losses, which are met with in a compressor built to deliver air at, say, 900 lb. per square inch. The conflicting loss factors introduced by multi-stage working were then discussed, and it was shown that a compromise gives the most efficient machine. The author expressed the opinion that a three-stage compressor, with its comparatively high mechanical efficiency and small valve loss, is superior to a four-stage machine, in spite of its slightly lower thermal and volumetric efficiency. In discussing the design of compressor as affected by working conditions, Mr. Quertier emphasised the necessity of increasing the work done in the low-pressure stages and reducing that in the high-pressure stage. If such practice

* The engine builders inform us that the volumetric output of this particular compressor was very generously rated. In recent practice the power required has been reduced to 7½–8 per cent. of the brake horse-power output.—ED. THE E.

were adopted, he thought that there would be less trouble with high-pressure valves and lubrication, particularly when the compressor was throttled down to deliver reduced quantities of air. An interesting point raised by the author was that regarding the very great divergence of opinion amongst the makers of Diesel oil engines as to the relative size of the air compressor as compared with the engine output. He ventured to express the opinion that engine builders have in the past insisted on a rather larger output from the compressor, to ensure, no doubt, a margin in hand for eventual wear, but mainly perhaps to give an excess capacity, for charging up the starting air bottles while the engine was running. In this respect there was a marked difference in marine and land practice. In motor ship work there was a tendency to design the air compressor to deliver only just the amount of air which was required to atomise the fuel used. Provision was made in one of the auxiliary sets for charging both the main and auxiliary starting air bottles. The suggestion was made by Mr. Quertier that such practice might be adopted with advantage in land stations, an auxiliary set being used to charge the air bottles. It was claimed that such an arrangement would enable the air compressors on main generating sets to be proportioned for the best efficiency, and that the amount of fuel thus saved would more than suffice to drive the auxiliary set when required. The recent developments in turbo-blowers for scavenging and supercharging were referred to, and several types of small compressors for bottle charging were described and illustrated. In closing this paper, the author remarked that the duty of a compressor for an oil engine was a heavy one, and that he knew that careful thought was continually being given to the improvement of details, such as valves, pistons, and high-pressure liners. He was of the opinion that a final design would perhaps never be reached. To-day's standard always seemed a jumping off place for what it was hoped would prove to be a new and improved design.

An Unusual Boiler Explosion.

In our issue of October 29th last we gave a brief account of a very unusual form of boiler explosion, in which a tube drew out of its header and was found to have been shortened in the process. No attempt was made at the official inquiry to explain the cause of this shortening, but Mr. C. E. Stromeyer, chief engineer of the Manchester Steam Users' Association, has investigated the matter and puts forward a theory in his Memorandum for the past year. The essence of this theory we give below.

The boiler in question was of the Babcock type, about ten years old, and was used to supply steam at the Hale End Works, Walthamstow. It was shown at the official inquiry that many of the tubes were badly choked with deposit, and that the tube which failed was completely blocked. It consequently became overheated and drew out of its header at one end. The resultant rush of steam scalded two men so severely that they died the same day.

In drawing out of the header the tube was buckled over about half its length of 18ft., and at the part where it was choked was swelled from its original diameter of $3^{15}/_{16}$in., so that the circumference, instead of being 12·781in., became in one place as much as 13·375in. Over a length of 66in. the average increase in the circumference was 0·211in. After the explosion, the end of the tube was, according to the official report, ¼in. clear of the header, which means, taking into account the length of tube inside the header, that it had shortened itself by 1¼in. The bending could not account for so great a reduction in length, and it is Mr. Stromeyer's aim to explain the discrepancy. He says:—

"The swelling of a tube's diameter should be accompanied by a shortening of its length, and it therefore seemed to me that the drawing out of this tube might be explained as due to its swelling. The possible action is somewhat complicated. If one of a number of tubes grows hotter than the surrounding ones, it would, not taking into account the steam pressure, expand both circumferentially and longitudinally, and being limited as regards movement by the adjoining tubes, it might be staved up or buckle, and if cooled down again would be shorter than the other tubes and might be drawn out of its tube holes. The withdrawal in this case might therefore be explained by severe heating and sudden cooling, but the estimated movements are far smaller than required.

"Another explanation—one that fits the present case admirably—is that the tube having become hot, its metal would become semi-plastic, and, yielding to the internal steam pressure, would increase its diameter. But when plastic materials yield they do not change their volume. Their specific gravity remains almost unchanged, so that any increase in one dimension is associated with the same decrease of the cross section. . . .

"According to the official drawing, over a length of 66in. the average circumference is 0·211in. greater than $12^{7}/_{16}$in., which is the circumference at other parts of the tubes, and therefore almost certainly the original circumference. The ratio of 0·211in. to the circumference is 0·0170, and therefore the 66in. should have shortened 0·0085 of this length, or 0·53in.' A careful analysis of the measured bending of the tube as recorded on the official drawing showed that this would account for 0·94in.

"Adding together the shortenings due to these two causes, we have 0·53 + 0·94 = 1·47in. The actual shortening, or, rather, the difference of length between the withdrawn tube and the adjoining tubes was $1^{19}/_{64}$in. or 1·30in., so that only 0·17in. remains unaccounted for, or, rather, this difference may readily be accounted for as being due to the pull on the tube before it suddenly slipped out of its one tube hole.

"Up to this point of time the tube would almost certainly be straight, for it must have been in a high state of tension, otherwise it could not have pulled itself out of its tube hole. But it would have to move 1in. to clear the header hole—¾in. thickness of plate and ¼in. projecting tube end. Momentarily, it would behave like a stretched spring, if released at one end. That end would move double the distance the spring had been stretched, and in its temporarily shortened condition it would experience a compression stress which would be exactly equal to the tension under which it started to move.

"In the present case therefore the tube end would move 2 × 0·53 = 1·06in., and just clear its hole, provided that the tube had remained straight, but being subjected to a temporary severe compression stress, and being in a plastic condition, it would buckle; in fact, it did buckle, and due to this buckling it shortened another 0·94in., so that for a short instant of time the end of the tube was 0·94 + 0·06 = 1·00in. clear of the header, but at once it returned to within about ¼in., as the compression stress disappeared.

"A stretching of 0·53in. on a tube length of 213in. implies a tension stress of 32 tons per square inch, but this has to be reduced on account of the shortening of the adjoining tubes, and also on account of the plasticity of the material, but it would be sufficiently intense, when changed into a compression stress, to account for the buckling of the tube."

THE WILLIAMS PRIZE.

On his retirement from honorary treasurership of the Iron and Steel Institute, in May, 1926, Mr. Illtyd Williams presented to the Institute the amount of £3000 stock of the 3½ per cent. Conversion Loan, the yearly interest of which is to be applied to the making of a money award for the best paper of a practical character, presented to the Institute and accepted for publication at the annual or autumn meeting each year.

The award is to be known as "The Williams Prize" in commemoration of the late Mr. Edward Williams, father of Mr. Illtyd Williams, and Past-President of the Institute, and also in recognition by Mr. Illtyd Williams himself of the honour in having been elected to serve the Institute as honorary treasurer for a long period of years.

The award will be made at the discretion of the Council, under the following conditions:—

(1) The author of the paper shall be a British subject, regularly employed in a British iron and/or steel works, or in a works situated in any British Dominion, and possessing blast furnaces and/or steel or iron melting furnaces. The author at the time of presenting the paper shall be employed in such works in a position not superior to that of manager of any one technical department, such as blast-furnaces, melting shop, rolling mills, foundry, &c. That is, he may be departmental manager, head foreman, roller, roll turner, melter, apprentice, &c.

(2) The paper or papers must be of a practical character, bearing on the manufacture or treatment of iron and/or steel.

(3) In the event of two papers being submitted and found to be of approximately equal merit, the Council may, at their discretion, divide the award between the two authors.

(4) In the event that, of the papers submitted in any one year, none is, in the opinion of the Council, deserving of any award, the Council may withhold the award in that year.

(5) If two or more qualified candidates collaborate in submitting a paper, which is adjudged suitable for an award, the Council may divide the award among the joint authors.

At the end of each year the Council will adjudicate upon all papers coming within the scope of the scheme and accepted for publication—excluding all reports presented under the Carnegie Research Scheme—and shall decide as to the paper or papers which, in their opinion, merit an award.

The Council has power to decide upon all questions which may arise concerning the administration of the fund, and the award of prizes; and the decision of the Council is to be final.

MERCHANT SHIP TRIALS AND SERVICE PERFORMANCE.

In the paper which was read by Dr. E. V. Telfer on Friday last, the 26th ult., before the North-East Coast Institution of Engineers and Shipbuilders, the question of the more accurate and systematic determination of ship propulsive performance is discussed. In his opening paragraph, Dr. Telfer reminds us that the vast full-sized experiment which is presented by every completed ship contributes but little to the general science of ship propulsion. At present the question of improved efficiency is left almost entirely in the hands of the model experimenter, whose methods necessitate the extrapolation of experience. The fields of model and ship experiment are correlated, and the ship field should be as fully explored as that of the model. In the author's opinion the duty of ship-field exploration rests with the practitioner. Dr. Telfer deals in the first part of his paper with the various types of trials, their inter-relation and the establishment of mutual consistency. He then goes on to show that the inter-relation would seem to suggest that the load trial should be disregarded as a test of speed and power, it being better to view it solely in the light of a calibration test of the propeller as an absorption dynamometer. The question of such a calibration and the getting out of a generalised power diagram, which enables the average power absorbed at any given revolutions and ship's speed to be determined, is thus dealt with. The load trial thus considered then becomes the key to the determination of average power at sea. This investigation is next extended to trials in the ballast condition, and the relative absorption of power by the propeller with any degree of immersion is further discussed. In the latter part of this first section the question of the power diagram and ship-model correlation is considered.

In the second part of his paper Dr. Telfer deals more especially with the problems of ship propulsion considered in relation to service performance. The relation of the power diagram to service data is made clear, and it is shown that such a diagram once constructed will hold good for all weathers, and practically all the usual conditions of the hull surface of the vessel, provided that the propeller remains unchanged. The analysis of service performace is next dealt with, and reference is made to weather classification, a weather intensity scale being developed, the use of which is illustrated by examples to show in what manner the sea qualities of ship can be compared and sea speed defined. The author then deals with the power diagram and its use in the detection of fuel waste under service conditions.

The third part of the paper contains proposals as to possible changes in trial routine, which are suggested by the methods of analysis discussed in the paper. Among other changes, a log trial is recommended in which a speed log recently introduced by Dr. Kempf, of the Hamburg Tank, would be employed. Such a trial, the author states, could be carried out very expeditiously, and quarter hour tests, at constant revolutions, could be made to cover the whole range of revolutions, a much greater number of indicator cards being taken than is the case at present. By such means an accurate determination of power would be possible. Dr. Telfer seeks to show how very useful, commercially, all trial work can be made, both to the shipowner and to his technical advisers, by the adoption of new methods, which, he states, would not only greatly increase the number of investigators, but would give a definite impetus to the present unsatisfactory study of the performance of the merchant ships.

THE JUNIOR INSTITUTION OF ENGINEERS.

On Friday, November 26th, a paper on "Petrol and its Substitutes for Use in Internal Combustion Engines" was delivered by Colonel the Master of Sempill. The lecturer opened by giving a short historical summary of the oil industry, and the present position of different countries with respect to the sources and destination of the quantity of oil consumed. The different grades of petrol were then dealt with and their characteristics as regards highest useful compression ratio and chemical analysis stated. Colonel Sempill considers that "cracked" spirit is superior from the point of view of compression ratio to "straight run" spirit when both are obtained from the same petroleum crude. An English "cracking" plant was described in detail. The various substitutes for petrol, such as benzol, naphthaline, alcohol and the products produced by the low-temperature carbonisation of coal were then treated in a similar manner. It seems that there is no possibility of power alcohol competing with petrol within any reasonable time, and though the other alternatives have their uses, there is every likelihood of petrol as derived from petroleum being without a rival for a considerable time to come. The lecturer was very sceptical of there being any immediate decrease in the world's oil supply. The remainder of the paper was devoted to those substances which are added to petrol to prevent detonation. Though beneficial results have been obtained with lead tetra-ethyl, it has certain disadvantages and a non-metallic substance is better than a metallic one. Toluidine and xylidine are the most promising of the non-metallic compounds. Colonel Sempill emphasised the importance of this branch of the subject, and considered that the finding of a suitable substance was one of the principal problems to-day concerning the internal combustion engine. An interesting discussion followed, which centred chiefly round "dopes," and many speakers gave their experiences with different substances.

At the forty-fifth sessional general meeting of the Institution held on November 12th, 1926, the following officers and members of Council were elected by ballot for service during the 1926–27 session:—Chairman, T. L. Kirlew, A.M.I. Mech. E.; Vice-chairmen, H. P. Wright and W. M. Hurrell; hon. treasurer, C. O. Mourant; hon. librarian, T. W. P. L. Mullings; hon. auditors, H. S. Rentell, A. P. Long, W. T. Marchment and C. R. Bird; members of Council, W. J. Leaton, J. F. Petree and F. Squirrell; as junior member under twenty-three, W. H. G. Churchill.

The chief point of interest at the meeting was the announcement of the result of a referendum which had been addressed to all the members in Great Britain as to the desirability or otherwise of admitting duly qualified women engineers to corporate membership of the Institution. There was a large majority against their admission.

CONTRACTS.

The Stream-Line Filter Company, Ltd., of 64, Victoria-street, Westminster, S.W. 1, has received an order to install a stream-line oil separator of 50 tons per hour capacity on each of the two ships being built for the Grace Line at the yard of the Furness Shipbuilding Company, Ltd., Haverton Hill-on-Tees.

Stein and Atkinson, Ltd., 47, Victoria-street, London, have received the order from the United Glass Bottle Manufacturers, Ltd., to supply for the latter firm's St. Helens Works, four Chapman gas machines and also to equip two existing Kerpeley producers with Chapman agitators and two producer buildings with coal elevators and conveyors and two railway wagon tipplers.

Les Ateliers de Constructions Electriques de Charleroi have received from the Belgian Post and Telegraph Department an order for the manufacture and laying of underground dry-core telephone cables between Brussels and Luxembourg, a distance of 247 kiloms., and between Brussels, Charleroi and Mons, a distance of 80 kiloms. The contract price is approximately £450,000.

It is officially announced by the Great Western Railway that the following contracts have been placed:—(*a*) For a 65ft. turntable to Newton Abbot, Ransomes and Rapier, Ltd., Ipswich; (*b*) for six 100 k.V.A. single-phase transformers for Park Royal generating station, the Metropolitan-Vickers Electrical Company, Ltd., 4, Central-buildings, S.W. 1; (*c*) for the erection of a transit shed at King's Dock, Swansea, Sir William Arrol and Co. (Swansea), Ltd., King's Works, Swansea; (*d*) for two 3-ton and two 6-ton electric cranes for South Quay, Newport Docks, Stothert and Pitt, Ltd., Bath; (*e*) for the overhaul of the steam hopper barge Sir Ernest Palmer, Harris Brothers, Ltd., Swansea; (*f*) for the overhaul of the tug Wolthound, the Tredegar Dry Dock Company, Ltd., Newport, Mon.; (*g*) for the overhaul of the tug Archibald Hood, Thomas Diamond and Co., Ltd., Cardiff; and (*h*) for the overhaul of the ss. Sir Walter Raleigh, the Bickle Engineering Company Plymouth.

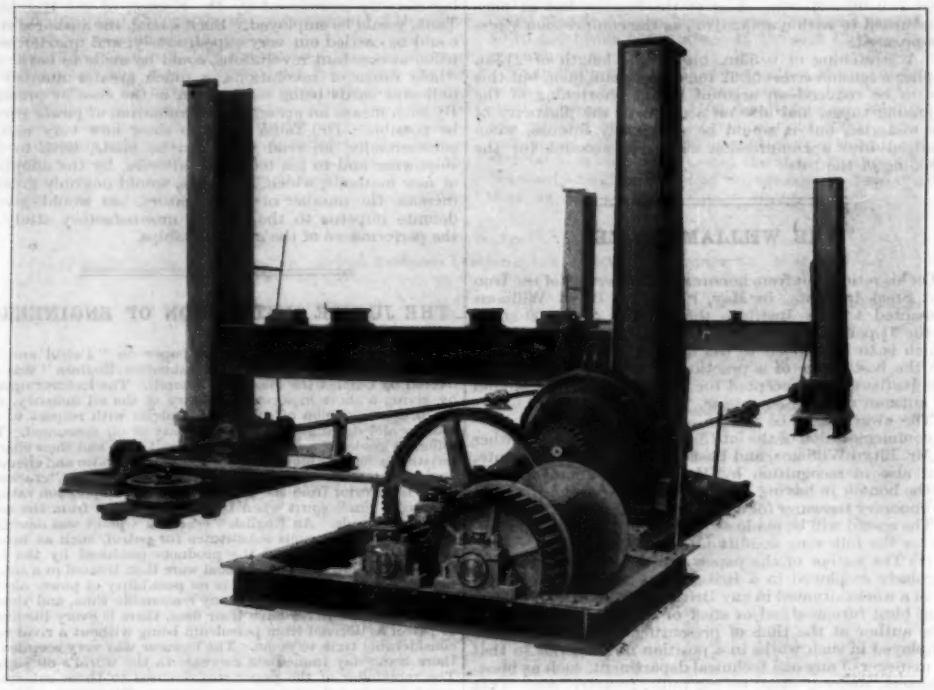
LAUNCHES AND TRIAL TRIPS.

Aeric Star, twin-screw steamer; built by Palmer's Shipbuilding and Iron Company, Ltd., to the order of the Blue Star Line (1920), Ltd.; dimensions, 494ft. long; 11,750 tons deadweight. Engines, twin-screw single reduction geared turbines; constructed by the builders; trial trip, November 26th.

Rajula, steamer; built by Barclay, Curle and Co., Ltd., to the order of the British India Steam Navigation Company, Ltd.; dimensions, 460ft. by 61ft. 6in. by 41ft. Engines, twin-screw, four-crank, triple-expansion; constructed by the builders; trial trip, November 26th.

LOCOMOTIVE HOIST FOR PORT ELIZABETH

THE LEEDS ENGINEERING AND HYDRAULIC CO., LTD., RODLEY, ENGINEERS



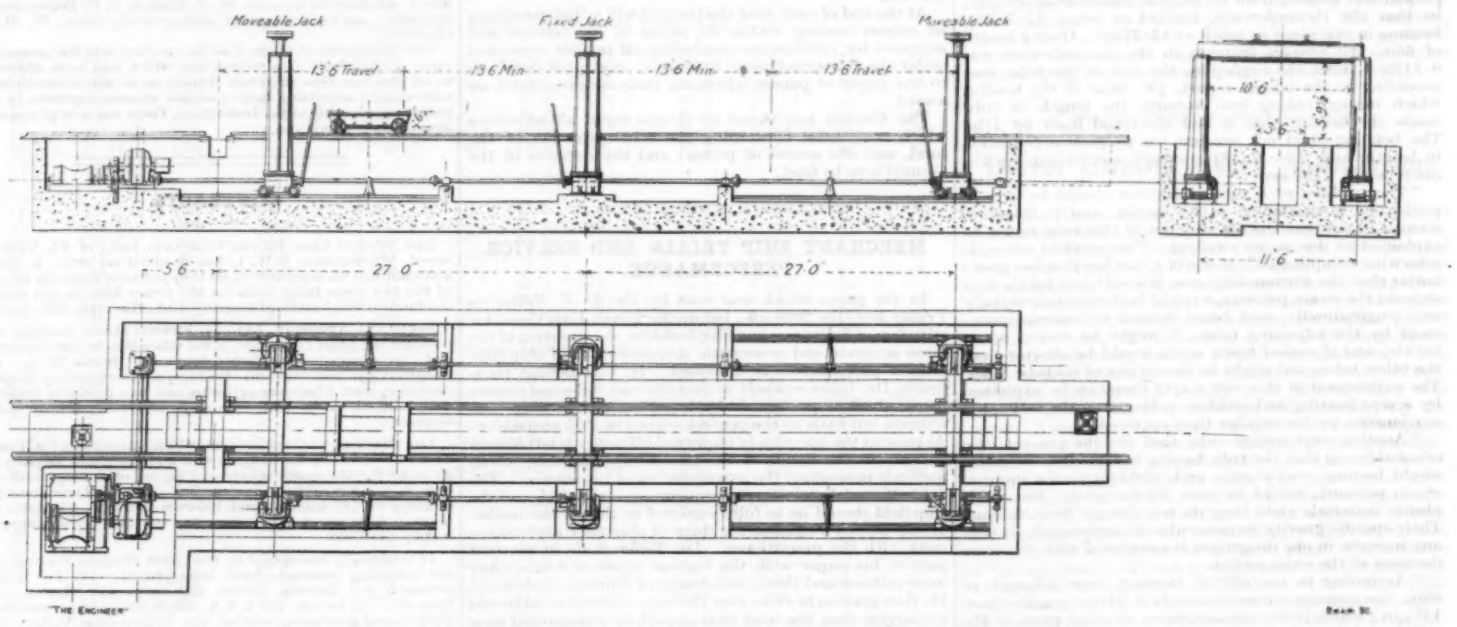
Locomotive Hoists for South Africa.

THE two machines which are illustrated herewith have been constructed by the Leeds Engineering and Hydraulic Company, Ltd., of Rodley, for use in the works of the South African Railways. Their purpose is to raise locomotives during repairs. The hoist illustrated by the drawing has three pairs of jacks. It will be erected in the East London Works, where it will deal with Mallet engines up to a total load of 134 tons, whilst the smaller hoist has only two pairs of jacks, and is designed to handle all other types of locomotives. It will be erected in the Port Elizabeth workshops. In the larger hoist the middle pair of jacks is stationary, but the two outside pairs can be moved longitudinally by ratchet gear.

As seen in the drawing, the heads of each pair of jacks are joined by a transverse beam. On each beam are fastened short pieces of rails, which fit corresponding gaps in the workshop rails when the rams are lowered. The locomotive being run into position with three pairs of wheels resting on the short pieces of rail, where they are locked in position, the jacks, screw operated, are set in motion by electrically driven gear. The gaps in the track rails are then filled in by suitable pieces. The maximum vertical lift gives a clear distance of 5ft. 9in. between the underside of the beam and the track rail table, and the distance between the jack columns is 10ft. 6in. The stationary jacks in the case of the East London machine are bolted to the concrete foundation, but the movable jacks are so mounted on flanged runners that when under load the weight is transferred direct to the track rails. Each pair of jacks is capable of lifting 100,000 lb.

A single electric motor operates all the jacks and also drives a geared winch for hauling locomotives into position. Its wheels having been removed, a locomotive can be lowered on to eight four-wheeled trucks, which run on the track rails. When replacing the engine on its wheels lateral adjustment may be necessary, and six ratchet-operated blocks are provided on the cross beam for this purpose.

The gearing is machine cut from the solid. The spur wheels are of cast iron and the pinions of mild steel; the worm wheels are of phosphor bronze and the worms of hard steel. The screws and worms are provided with ball thrust bearings, and the square-threaded screws are fitted with deep gun-metal nuts mounted in crossheads and furnished with machined guides. The worms and wheels are totally enclosed and arranged to work in grease. The motors and electrical equipment were made by the British Thomson-Houston Company, Ltd., the former being half hour rated, totally enclosed type, and the latter of the air-break reversing drum type, with five minute rated protected type resistances.



LOCOMOTIVE HOIST WITH THREE PAIRS OF LIFTING JACKS

PERSONAL AND BUSINESS ANNOUNCEMENTS.

JOHN CASHMORE, of Great Bridge, Staffs., asks us to state that he has purchased for dismantling and breaking up the works of John Turton and Sons (Vulcan Forge and Rolling Mills), Ltd., of Sheffield, and has already commenced on this work, and that he has also commenced dismantling the works of Roberts and Cooper, Ltd., Bromley Ironworks, Brierley Hill.

MR. REGINALD BROWN, M. Inst. C.E., asks us to state that he has moved his offices from 70, Victoria-street, Westminster, S.W. 1, to Westminster Chambers, 5, Victoria-street, Westminster, S.W. 1, and that he has taken over the engineering practice of the late Major T. J. Moss-Flower, A.M. Inst. C.E., of 28, Victoria-street, Westminster, and Carlton Chambers, Baldwin-street, Bristol. Arrangements have been made to continue the offices at Bristol as a branch of the London offices.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Market Situation.

THOUGH a brighter tone prevails on the Midland iron market the actual business position shows only slight improvement. One can hardly expect either producers or consumers of iron and steel to accept or place orders until prices can be determined, and at the moment that is impossible. Fuel at competitive prices cannot be obtained, and production of iron and steel at a saleable market level with present costs is claimed to be impossible. Coal and coke prices will be the deciding factor. On 'Change in Birmingham to-day—Thursday—it was the considered opinion of many that a stage will shortly be reached when buying will be possible. The removal of the restrictions on the distribution of coal is a matter of great importance to several iron and steel industries, such as tubes, and, as soon as prices come down, an additional number of mills will restart. Habitues of the Birmingham exchange consider the position in the Midland industries much more favourable. Most engineering and manufacturing firms have plenty of orders on their books, and are only held up by the inadequacy of either fuel or material or both. Inquiries for material were to-day very numerous and gave promise of an active period to come. Generally speaking, however, hopes seem now to be concentrating on the New Year.

Industrial Optimism.

The entry of the coal stoppage upon its last stage is a matter for satisfaction to the iron and steel trades, and Midland industrialists are optimistic as to future trade prospects. So confident that their hopes are based on solid foundations are some of them, that they predict a large re-absorption of present unemployed labour within a comparatively short time. Many recognise that for this year the mischief is done, and the restoration of activity cannot come until the New Year. But it is generally agreed that, when adequate supplies of fuel are forthcoming at reasonable prices, industry will at once forge ahead. Mr. Gilbert C. Vyle, President of the Association of Chambers of Commerce, offered a word of warning, and expressed hope that the revival that he foresaw would not be exaggerated into a boom, which was the last thing that was wanted. The release of orders which had accumulated during the stoppage, unless viewed in its true perspective, might, he said, create a false impression. There was no doubt, however, that there was going to be very much better business. There was every indication of that last February, and they might hope to see trade increasing every month as things settled down and the country got back to work. He feared that a considerable amount of work had been permanently lost, though not so much as might have been expected.

Blast-furnace Restarted.

The blast-furnace of M. and W. Grazebrook, Ltd., Netherton, Dudley, which has been idle since July owing to the coal strike, was restarted this week. It is stated that the firm has numerous orders on its books, and that the restarting of the furnace will result in increased activities in other directions.

Raw Iron.

Chief interest on the Midland market in Birmingham to-day was centred round pig iron, for, until that material is available in large quantities, many of the works will continue to be held up, and engineers will be unable to get into full swing. Up to the present pig iron stringency has not been relieved, but foundries have now been promised some iron in the near future from two Derbyshire furnaces. These furnaces, now being restarted, are part of a big self-contained production system, and they will be under no

anxiety as to finding outlets for their putput. The price named for No. 3 foundry is £4 12s. 6d. at furnaces. It is hoped some deliveries may be made before the turn of the year. Meanwhile the foundries are being kept going by Northern iron, which, however, is only available in limited quantities, and by continental pig. Shipments of the latter are arriving in rather better time than recently. Some purchases of this raw material from abroad cover requirements up to next February, and it is likely enough that much more will be bought before normal production is reached at the British furnaces. It is, of course, recognised that pig iron cannot be produced under prevailing conditions at any price which the market would pay, except as a temporary expedient. Blast-furnacemen who have collieries and coking plants in association with them may find it worth while to re-light furnaces in order to get their own foundries going and to accommodate customers. Those smelters who lack these collateral supports are unable to follow suit. They have no assurance of coke supplies, and assuming they can get the coke there is no inducement to blow in furnaces unless they can see their way to produce pig iron at a saleable price. Some of the South Staffordshire forges are again in operation, and the mills are making a better output, though they are still working under great disabilities owing to the disordered state of the fuel supply. There is very little furnace coke on offer and quotations vary considerably.

Steel.

There is little or no change in the steel department of the Midland market on the week. There are plenty of orders available. Constructional engineers are getting daily inquiries, which, however, can hardly be handled through the inability to get steel quotations. A fair amount of re-rolling of foreign material is still being done in this district. Carbon billets are in good demand at slightly increased rates, and foreign structural material is in request. Until production costs can be safely estimated firm steel quotations will be hard to get. Producers are awaiting costs and consumers' prices, so that the market hangs fire.

Scrap.

The scrap market has been strengthened a little by the recent turn of events, and more business is being done.

Finished Iron.

There is no prospect of any general resumption of work in the Staffordshire bar iron industry till the price of fuel has subsided very definitely. There is always a small demand which will be satisfied if possible, irrespective of costs; but it is vain to suppose that market activity can be rekindled on any considerable scale with prices at their present level. A relatively small tonnage of Crown iron is reported to have been made during the week in Lancashire. Black Country nut and bolt makers are having to rely almost entirely upon Belgian common finished iron. The output of the former is at present very much below normal.

Sheet Prices.

The lull which commonly falls upon the galvanised sheet trade at this season is apparent in an easing of prices. The effective mill capacity has not been entirely taken up for next month, and some of the big concerns are looking for more outlets in January. Galvanised corrugated sheets of 24-gauge were this week quoted £17 10s. for home consumption, a reduction of 5s. per ton on last week's quotations. On 'Change in Birmingham to-day it was considered they were likely to become still cheaper with the increased supplies of fuel. Export business is stated to have been done at £17 5s. Good orders have been booked with the Far East and the Malay Peninsula, but sheet makers are not very well satisfied with the position in competition, especially with America, and lower prices will be welcomed by the makers whenever they become possible.

Fuel.

The fuel position does not show much improvement on the week, although there are plenty of opinions within the trade in favour of a drastic reduction in coal prices. In some cases certain large coke-makers have accepted orders at figures substantially below those now current, and a severe cut in coke prices would not be a matter for surprise: There are still large quantities of foreign fuel to be delivered, and, in a month, the supplies of coal may be considerably larger than they are at present. The anticipated cut in coal prices will have an important effect in encouraging the manufacture of furnace coke. With the present high prices there is little inducement to make coke, the sale of raw fuel being a much more attractive and profitable business.

Mining Situation.

There has been a big resumption of work in the Midland coalfields this week. After a spell of thirty weeks the stoppage in this area is now officially ended, though up to the time of writing agreements had not been reached in some districts. Negotiations between owners and men are, however, proceeding. Meanwhile output has now reached normal level in the Notts., North Derbyshire, South Derbyshire, Leicestershire, Cannock Chase, Staffordshire, Worcestershire, Shropshire, and Warwickshire areas. So far as Cannock Chase is concerned they had a good start, for the stoppage was really over many weeks ago, when more than 19,000 of the 25,000 colliers in the area had returned; but, with the official lifting of the ban, the thin lines of "diehards" were free to go back to the pits without defying the orders of their union.

Notts Miners' New Move.

A movement has, I understand, been launched by representatives of the Notts. miners, who returned to work before the official settlement, for the formation of a new union. It is proposed that the organisation should be known as the Notts. and District Miners' Industrial Union, and that the aim should be entirely industrial, none of the union funds to be used for political purposes.

Research in Coal Mining.

A new coal treatment laboratory, the first of its kind in the country, has just been added to the Mining Department of the Birmingham University and will prove, it is hoped, of great value to the mining industry and coal users generally. The new laboratory, which is probably without equal in the completeness of its equipment in Great Britain, has been instituted to enable the Mining Department to extend its activities of research and instruction in relation to the preparation of coal for the market. To provide for the construction and equipment of the laboratory, funds amounting to £9400 have been granted by the Committee of the Welfare Fund, and the firms which have supplied the machinery have shown their practical sympathy with the development by bearing a proportion of the cost of the apparatus they have installed. It is estimated that the operating expenses will not be less than £1500. The new laboratory was formally opened on Friday last by Viscount Chelmsford.

Coventry Engineering.

A slight improvement is discernible in the motor engineering industry in Coventry. Consignments of raw material received have enabled work to assume more normal conditions at some of the big works. The outlook, is, however, by no means clear, for it is evident that the ground lost during the past six months will be difficult to regain. Prospective orders are slow in materialising, and those firms which are fairly active owe their favoured position largely to substantial block orders for overseas running over varying periods. One or two concerns, however, are moderately busy on production for the home market as well as for overseas.

Scientist's Valued Work.

Professor Thomas Turner, of Birmingham, who was for a long period associated with the Staffordshire Iron and Steel Institute, and whose name is distinguished in metallurgical science, will be the central figure in a ceremony at Mason College, on December 3rd, to mark his retirement from the University of Birmingham. A presentation will be made to him by Mr. Neville Chamberlain, which will include a photograph of the Professor, to be hung permanently in the Metallurgical Department at Edgbaston. The *personnel* of the gathering will be an indication of the valuable contributions made by Professor Turner to the science of metallurgy. His research work has covered a wide field, and he has done much that has borne an intimate relationship to the development of Staffordshire industries. Results of research work which he conducted upon the influence of silicon and other elements in iron and steel have been applied in iron foundries throughout the world, and he has devoted special attention to the properties of metals, such as structure, hardness, volatility, &c.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Road Tar and River Pollution.

A FULL day's conference devoted to its discussion must be unique in the history of coal tar. Such an event, organised by the Society of Chemical Industry, the Coke Oven Managers' Association and the Institution of Gas Engineers, took place last week-end in the College of Technology, Manchester, when about a dozen papers were read and discussed. Tar as a road material was dealt with in two contributions. In one, by Messrs. W. Gordon Adam and F. W. Robinson, it was pointed out that thirty years ago all the roads in the country were water-bound. To-day, all the "A" roads and most of the "B" roads and some of the others were waterproofed, and were no longer muddy in wet weather, dusty in summer, and apt to develop into quagmires after severe frost. Discussing the use of coal tar, the authors stated that much work had been done to eliminate from road surfaces the poisonous elements which had been accused of damaging fish in rivers into which roads drained. Several processes were now being used, and it was hoped to experiment with them on a large scale during the coming summer. Mr. M. Barash, in the course of a paper, claimed for tar as a road material remarkable anti-skidding properties. Surfaces in which it was used as a binder gave a sureness of grip to all kinds of traffic which was seldom achieved by any other waterproofing method. Its economy and ease of working in construction and repair, and its durability and freedom from dust, were other advantages.

Electricity in Agriculture.

Discussing the problem of the use and supply of electricity for agricultural purposes before the Students' Section of the Institution of Electrical Engineers in Manchester, Mr. J. A. Sumner submitted that electrical development had passed through the stages of lighting and concentration upon industrial power supply, and that electrical engineers should now look to its development agriculturally, with a consequent development of overhead transmission. Dealing with ploughing as an illustration of the use of electricity actually on the land, Mr. Sumner suggested that the supply authority should buy the electrical ploughing equipment and plough for farmers by contract. The cost of running a 20 horse-power machine would be 5s. 10½d. an hour, or 11s. 9d. an acre, as compared with about 23s. an acre with a four-horse team. For any rural scheme to be completely successful, it was necessary that the whole of the machine work in the area should ultimately be done electrically.

Local Contracts.

Orders from Australia and New Zealand have been received by the Metropolitan-Vickers Electrical Manufacturing Company, Ltd., Trafford Park, Manchester. For a New South Wales colliery the firm has received an order for an electrical winder to raise coal to the surface from a depth of 420 yards at the rate of 490 tons an hour. Contracts for generators and transformers in connection with the Waikare Moana hydro-electric scheme, to the value of £45,000, have also been placed with the Metropolitan Vickers Company by the New Zealand Government. Beyer, Peacock and Co., Ltd., of Gorton, Manchester, has received an order from the Federated Malay States Railways for seven "Pacific" type express passenger locomotives.

The Third Port.

Manchester is patting itself on the back on having regained the position of third British port, which was lost to Hull four years ago. According to the annual statement of the Board of Trade, Manchester comes third—a poor third, it is true—with cargoes handled last year to the value of £115,647,548, compared with Hull's £115,083,167. Manchester's traffic has shown a steady growth from £86,500,000 in 1921.

Non-ferrous Metals.

The demand for the non-ferrous metals is still moderate, but the market's belief in the sound statistical position of tin has been reflected in a steady rise in the quotations for this metal, the close on Friday last representing an advance of nearly £6 10s. on the week. Monday's opening this week witnessed a further rise of £4 10s., the price of spot metal being little below the record for the past five years. Tuesday, however, saw a decline of about £3 per ton. With a reduction last week of 140 tons in warehouse stocks in London and Liverpool, it is not unlikely that prices will remain firm, with the usual periodical relapses, for the time being. The demand for copper has been limited, and prices have given way a little. Both lead and spelter have been quiet markets, but with prospects of an increased consumption now that the coal stoppage is at an end, values have been steady, and in each case slight gains have to be recorded compared with the previous week.

Iron.

Makers of pig iron in the Midlands, generally speaking, are adopting a cautious policy for the time being with regard to the restarting of their blast-furnaces in the hope that within the next week or two fuel will be available at prices more closely related to the figures at which many of the orders on their books—a large number of them being the balance of pre-strike contracts—were accepted. In spite of this, however, a start was made at the beginning of this week by one of the largest concerns, two blast-furnaces being put into operation. This particular firm is more favourably situated than most of the others from the point of view of coal and coke supplies, having its own collieries and coke oven plant. Production, however, is likely to be earmarked for some time in fulfilment of contracts, although small parcels are being disposed of at 92s. 6d. per ton at the blast-furnaces. There is no general market quotation yet for Midland common irons, and what prices will be within the next few weeks is a matter of conjecture, but 80s. to 82s. 6d. per ton on rail is considered a likely figure, if coal prices settle down to no more than half a crown above the April level. Scottish iron for prompt delivery is easier at 132s. 6d. per ton, with Middlesbrough at 135s. Practically all of the bar iron makers have resumed operations, and a steady run is expected for some time. Prices remain at £12 10s. per ton for Crown quality and £11 5s. per ton for seconds.

Steel.

At the moment there is very little steel available for prompt delivery, but a steady resumption is anticipated, and a few of the mills are expecting to be able to deliver small quantities within the next week or two. The tone of the market remains very firm, with boiler plates quoted for delivery "after resumption" at £11 15s. to £12 per ton; tank plates at £8 17s. 6d. per ton; joists and sections at £8 2s. 6d. to £8 5s. per ton; and basic bars at about £9 5s.—delivered into the Manchester district. For prompt delivery small re-rolled bars are offered at about 5s. per ton lower than last week at £9 15s., the reduction being explained by the fact that makers for some time have been using much dearer fuel and semi-finished materials. Sellers of continental materials are meeting with a very poor response, and there has been a slight falling away in some of the prices now being quoted. For delivery into this area for cash against shipping documents, billets are quoted at £6 to £6 2s. 6d.; sheet bars at about £6 7s. 6d.; Siemens plates at £7 15s.; light plates at £7 10s.; joists and sections at £6 15s.; wire rods at £7 2s. 6d.; and steel bars at £6 15s. per ton. Few of the galvanising works are quoting, but the feeling of the market is that prices are rather easier at £17 per ton f.o.b. for the 24 gauge sheets.

Scrap.

There is no improvement yet in demand for the scrap non-ferrous metals, and in one or two instances, probably in sympathy with the new metals, lower prices are being quoted. Braziery copper is quoted at £52, heavy copper scrap at £61 to £62, selected gun-metal at £53, lead at £20, zinc at £25 10s., brass rod turnings at about £40, and heavy yellow brass at £45 per ton for graded materials, delivered to buyers' works.

Manchester Association of Engineers.

The President of the Manchester Association of Engineers, Sir Benjamin Longbottom, and Lady Longbottom, entertained the members and their ladies at a conversazione held at the Manchester Corporation Art Gallery on Friday last. The gathering was large and representative, and a thoroughly enjoyable evening was spent amongst the city's art treasures, which form one of the finest collections in these islands. In addition to the artistic attractions, there was a popular musical entertainment. The question of skill in industry was recently

discussed by Professor T. H. Pear in the course of a paper on "The Human Factor in Engineering," delivered to the Students' Section of the Association. Some day, he said, we might find that where there was a threat of withdrawing "skills" which were used as bargaining assets, those skills might be shown to be not so valuable as they were thought to be. In accountancy, secretarial work, and engineering of certain types, the tendency was that skills which used to be indispensable and were bargaining assets were being deliberately replaced. These skills, affirmed Professor Pear, were regarded as something offering a challenge to the inventor, something to be got rid of. He was not prepared to say how far the general strike threw light upon the question of the replaceability or the irreplaceability of certain skills, or how far certain skills thought to be high-grade turned out to be low-grade. In industry, however, there was a tendency in certain directions to regard skill as something which must be evaporated, and there was even a definite statement in some cases that skill should be filtered into relatively few hands.

BARROW-IN-FURNESS.

Hematite.

The sooner the various mining districts get working again the sooner will there be a possibility for the makers of hematite pig iron to restart their furnaces. With the agreement in Yorkshire and the possible return in Durham and other coalfields, the chance of an early return to normal conditions, both as regards deliveries and prices, is nearer; but from all signs it does not appear likely that there will be any production this year, keen as the makers are to start on the heavy orders which they hold. There has not been much business done just recently for the obvious reason that most of the big consumers had placed orders some time ago and before iron reached the price it is to-day. The market continues firm, and is likely to stay so, according to present signs. Apart from ordinary qualities, there have been many orders placed for special qualities of iron at the various works. As to the continental and American trade, very little can be said about it at present.

Iron Ore.

The outlook in the ore trade is fairly good, and as soon as the furnaces are in blast there will be a steady demand for both local and foreign ore. Quotations at the moment are not very reliable, but that will be remedied in the early future. The price of foreign ores will depend to some extent upon how freights are ruling. They have been up for some time.

Steel.

The steel market is dull, and few orders are about at present. The makers are not without orders, but the position is not as good as in the iron trade. Perhaps when there is a possibility of fixing dates for delivery the market may improve in tone. The hoop works continue to run uninterruptedly, and there is a good outlook for this industry.

Shipbuilding and Engineering.

Shipbuilding will be held up for a month or more yet, owing to the fact that steel makers will not be able to deliver material, the lack of which has rendered many men idle in this district The prospect is better, and the further contract with the Admiralty for three submarines will create more activity. It is hoped that further contracts will be announced shortly. The engineering departments are busy and likely to be for some time, and double shifts with some overtime still obtain.

SHEFFIELD.

(From our own Correspondent.)

The Strike and After.

WITH the conclusion of the coal dispute, all thoughts are being bent upon the future of trade. The agreement for Yorkshire and Derbyshire, which was signed on Monday, provides for a lengthening of the working day by half an hour, and it is expected that the pits—many of which have been working to a greater or lesser degree for some weeks—will be in full swing again very shortly. The resumption of coal supplies will not, however, mean full activity at the Sheffield works at once. Before the manufacturing trades can increase their output they must have supplies of steel, and before these supplies can be produced the furnaces must have pig iron. As the number of blast furnaces at present working in the country can be counted on the figures of one hand, and as furnaces which have been standing idle for some time cannot resume work without considerable preparation, it follows that steel will not be available for some weeks. It is not, in fact, expected that any appreciable improvement will be shown during the present year, although there is a good deal of work to be got on with when conditions make it possible. At present there are just a few Siemens furnaces working, but the firms owning them need the material thus produced for their own manufactures. The production of steel for general sale has not yet been resumed.

The Need of Price Control.

Most of the leading firms report that they have good order books, and that the trade outlook is cheering, providing that propitious conditions can be established. Some authorities go so far as to say that Sheffield, after five years of depression, is on the threshold of a period of renewed prosperity; and even the most cautious agree that there are large arrears of work to be caught up and that activity for some months seems assured. But a great deal depends on prices of fuel and semi-finished steel, and the necessity of keeping them at a reasonable level is being strongly emphasised. In the words of Sir Arthur Balfour, great self-control in the matter of prices will be needed during the next few weeks. The important thing is that when the steel makers restart operations they should not put their prices too high. If they do that, and make raw material in the form of billets too dear, they will kill the export trade. If a reasonable attitude is adopted, Sir Arthur thinks that the city will do quite a good trade early in the New Year.

Colliery Supplies.

With the restarting of many pits there is naturally a revival in the demand for winding and haulage ropes, and also for several classes of tools and appliances. The home trade in wire ropes has been severely restricted by the coal strike, though there has been a good sale for Sheffield ropes in overseas markets, where foreign competition is not very strong. Colliery ropes, however, especially those used in damp workings, deteriorate as much from idleness and neglect as from actual employment, and a good demand for new supplies is expected; in fact, orders and inquiries are already coming in. Makers of engineers' and other tools are looking forward to an improved demand in the New Year.

A New Colliery Railway.

An interesting enterprise for the direct conveyance of coal from pit to port is announced by Pease and Partners, owners of the Thorne Colliery, in the Doncaster area. They have given notice of their intention to promote a parliamentary Bill next year by which they will seek powers to construct a railway from the colliery to a point near the public road from Goole to Swinefleet and on to the river Ouse. They also propose to erect an overhead conveyor with a bridge and a pier or wharf. The scheme, in brief, is to take a line as the crow flies across Thorne moors to the river Ouse, a distance of about 4 miles, and to construct a private wharf. The company also intends to seek powers to work the intended railway by steam or electrical power generated at Thorne Colliery or elsewhere, and to lay down cables, mains, wires and apparatus. Another colliery matter of interest relates to the development of a pit at Barlborough, near Chesterfield, by the recently formed Furnace Hill and Renishaw Park Collieries Company, Ltd. Such progress has been made that the High Hazel seam of coal has now been reached. Earl Fitzwilliam is at the head of the company.

Smokeless Fuel Developments.

It is announced that new plant for producing smokeless fuel and oil from coal will shortly be in operation at Barnsley. There is to be a series of five batteries, each taking 50 tons of coal per day, so that a continuous daily throughput of 200 tons will be assured. Part of the plant will be working by the end of January, and the whole of it before the end of March. In order to obtain reliable data as to costs of maintenance and the value of the by-products, experiments will be conducted for periods of three, six and twelve months.

Coal Working near Leeds.

The Railway and Canal Commission has been occupied several days in dealing with a proposal to work coal in an area of 274 acres at Oulton and Woodlesford, between Leeds and Wakefield. The application was made under the recent legislation providing for such cases, and was put on the ground that, owing to the surface ownership being divided among a large number of parties, there was danger of the coal being left unworked. In the first instance, rival applications were made by J. and J. Charlesworth, Ltd., colliery owners, and Henry Briggs, Son and Co., Ltd., of the Whitwood Colliery, near Leeds, each of whom asked for powers to develop the whole area. In the course of the proceedings, however, the parties agreed to a partition scheme, under which part of the coal is to be worked from Messrs. Charlesworth's "Fanny" pit, and the remainder from the Water Haigh Colliery belonging to Messrs. Briggs. The Court sanctioned this division with a slight modification.

Cutlery and Plate.

Taken as a whole, the cutlery and plate branches are but poorly employed, and many operatives are either wholly or partly out of work. There are, however, a few exceptions in which firms are quite fairly well occupied. The special Christmas trade is not by any means exhausted, and many orders for odd lots are coming in. The *Journal* of the Sheffield Chamber of Commerce reports that quite a good trade is being done on account of home hotels, restaurants, &c., for table cutlery and cheap plated goods. It goes on to state that really big orders have come in just lately for stainless dessert knives and similar products. The output of stainless cutlery during this year has been large, and almost if not quite equal to that of 1925. I hear, however, many complaints as to prices and profits, excessive competition having brought the selling rates down to a level which is hardly remunerative. There is a brisk overseas demand for cutlery, and the trade in Sheffield safety razor blades continues to develop to a satisfactory extent.

A Lincolnshire Drainage Scheme.

The Ministry of Agriculture has issued a draft order stating that in the interests of the drainage of the fourth district of Lincolnshire, it is essential that the Little Steeping River from Steeping Mill to Wainfleet Stanch, a distance of 8¼ miles, should be cleansed and restored to its original 21ft. bottom, and that the banks and certain weak places should be strengthened. The General Commissioners have been empowered to put the work in hand immediately, and to borrow £15,000 for the purpose. The full cost will be £20,000, but the Government is providing £5000, and the remainder will come from the area by tax. The scheme has been approved at the annual meeting of Spilsby farmers.

New Sugar Beet Factory.

The new sugar beet factory at Selby, for which a site has been purchased on the East Riding side of the river Ouse, is to be commenced shortly. The Central Sugar Company, of Peterborough, is carrying out the scheme, and has for some time been making arrangements to get the required acreage of beet grown. The produce of about 5000 acres is required, and towards this quantity 2000 acres has been guaranteed in Lincolnshire. The arrangements contemplate the keeping of the factory at work all the year round.

Work for New Zealand.

The Metropolitan-Vickers Electrical Company, which has a branch in Sheffield, is among the firms whose tenders have been accepted by the Government of New Zealand in connection with the Waikare Moana hydro-electric scheme. It is to supply generators at a cost of £29,242 and transformers at £15,794.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Miners' Return.

MOST of the pits of Northumberland are now humming with an industrial activity they have not known since April 30th. All the collieries are not likely to be in working order until about the end of next week, but as most of them have been kept in good order during the past six months, it is not expected that coal-drawing will be much delayed. Here and there hitches occurred at the reopening of the pits, but it was not expected that everything would be smooth sailing at the start. There may also be a certain amount of dissatisfaction regarding the setting-on of men, but such things are inevitable under the circumstances. Normally, about 55,000 men and boys are employed at the mines in the county, and it is estimated that 40,000 have restarted this week. The Northumberland owners' terms were accepted by an overwhelming majority. Briefly, these are:—A 7½ hours' working day (plus one hour winding) for hewers; eight hours' day for other underground workers; 49 hours' week for surface workers; 6s. 9½d. per shift subsistence allowance; division of surplus profits, 87 per cent. to men and 13 per cent. to owners; and a two years' agreement. The ballot in Durham County announced on Tuesday showed a majority in favour of rejecting the owners' terms, but as it did not amount to two-thirds of the total votes cast, the men were ordered to return to work immediately.

New Shipbuilding Orders.

Shipbuilding prospects are showing a welcome improvement on the North-East Coast. A large number of orders, chiefly for moderately sized cargo boats, have of late been booked, and it is evident that directly material is available, there will be a fair amount of activity in the bulk of the yards. During the past few days simultaneous orders for eight oil-carrying vessels have been secured by Tyne firms. Six of the vessels have been ordered by the Anglo-Persian Oil Company, three of which will be built by Palmer's, two by Armstrong, Whitworth, and one by Swan, Hunter and Wigham Richardson. Swan, Hunter have also secured a contract for two tankers for other owners. The firm has now so much work in hand for its two Tyne yards that it purposes to reopen the yard on the Wear and transfer some of the work there. The same firm has in hand the Singapore floating dock, two Dominion and Commonwealth liners, and several other vessels. Palmer's building programme comprises about a dozen vessels, including a British cruiser. Armstrong, Whitworth's have orders for eight vessels, including two submarines for the Yugo-Slav Government. At Hawthorn, Leslie's Hebburn Yard another cruiser is being built, and the battleship Nelson is being completed at Armstrong, Whitworth's naval yard at Walker. On the Wear, Pickersgill and Sons have booked an order for a vessel of about 7000 tons deadweight carrying capacity. Short Bros. have three new orders which, with other work they have in hand, will keep their yard going for about twelve months. It is also understood that Sir James Laing and Sons, in addition to two Silver liners they are constructing, have other orders, including two of the new tankers for the Anglo-Persian Oil Company. Apart from the work on the stocks, there are something like twenty orders on the books of the various firms on the Wear. Operations at all the yards are, of course, held up at present owing to the shortage of materials, and there is not likely to be much activity until the New Year.

Cleveland Iron Trade.

A cheerful tone prevails about the Cleveland pig iron market, and everybody seems convinced that there are busy times ahead. The fact that the Durham miners have been ordered by their leaders to return to work is a matter of great importance to the Cleveland iron trade. Because they are in close proximity it is the Durham pits which feed the Cleveland blast-furnaces, and not till good supplies of fuel are forthcoming from these pits can the furnaces be restarted. Those at Skinningrove are merely damped down, and might be got away in a week or ten days, but all other blast-furnaces in the district have been raked out, and consequently need re-lighting, and will take longer before they are producing iron of a commercial quality. But even the re-lighting of most of the furnaces must be delayed until coke is at a reasonable level, and none can foretell when that point will be reached. There is talk of sales of blast-furnace coke at 30s. per ton, but even that seems too high a figure for the pig iron industry, and it will need to come down to the region of 25s. before pig iron can become an economic proposition. At the moment buying on any scale is in abeyance. Quotations, however, are still unchanged at 120s. per ton for No. 3 G.M.B. Cleveland pig iron; 125s. for No. 1 foundry; 119s. for No. 4 foundry; and 118s. 6d. for No. 4 forge. These rates are, of course, prohibitive to most consumers, but some of the makers are quoting for forward deliveries. Contracts have been fixed over six months on the basis of 82s. 6d. for No. 3 Cleveland pig iron, but for shorter contracts up to about the end of February 85s. is asked. These figures inspire a hope of an early recovery of the export trade. The French export figure has been fixed at 85s.

per ton f.o.b. Antwerp, up to the end of February, so that Cleveland prices will at once be down to a competitive level, and the number of foreign inquiries circulating indicates that as soon as freights are at a reasonable level and deliveries can actually be promised there will be plenty of business.

Blast-furnaces to Re-start.

Now that fuel supplies from Durham County are assured, active preparations are taking place in the Cleveland district to re-start iron and steel works. Dorman, Long and Co., Ltd., are starting six blast-furnaces next week; the four at Skinningrove, which have only been damped down, are being put into full blast; and Bolckow, Vaughan and Co., Ltd., are lighting up a number of furnaces as soon as fuel is available.

Iron Trade Wages.

Under the North of England manufactured iron trade sliding scale an advance of 5 per cent. in puddling and other forge and mill wages has been conceded as from Monday last. This is based upon the average net selling price of manufactured iron for the two months ended October 31st, which was £11 19s. 9·81d. per ton, compared with £11 12s. 0·34d. per ton in the previous two months.

Hematite Pig Iron.

The position in the East Coast hematite pig iron trade is unchanged. There is no prompt iron, but makers are prepared to accept forward contracts at round about 90s. per ton for mixed numbers.

Manufactured Iron and Steel.

Producers of finished iron and steel are in a very good position, all have big order books, and are only waiting for fuel in order to make a start. Some, indeed, have started rolling, but production must, of course, be limited until the blast-furnaces and steel furnaces are re-lighted and a continuity of operations is possible. In the meantime minimum prices are unchanged, but manufacturers are asking premiums in some cases.

The Coal Market.

A very difficult position prevails on the Northern coal market. The embargo on foreign shipments is preventing fitters from quoting, because they do not know when they may be able to deliver, and buyers know that, by the time there is unhindered loading, coals may have so increased in output as to make it impossible to maintain anything like the level of prices now talked of for the first month. Buyers are not eager to place orders at prices ranging from 30s. to 40s., according to grade. There are many inquiries from abroad for fuel, but high prices do not seemingly appeal to the foreign consumer, sorely as he may be feeling the shortage of coal. From the point of view of the general community, the market situation has undergone a rapid change. Fifty shillings at the pithead a week ago became 33s. 6d. in one instance at the opening of this week, with 35s. as the price per ton delivered within a certain short radius. Other collieries reduced their prices as circumstances permitted, and there is now every indication that prices will quickly fall to about normal level so far as domestic consumption is concerned.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding: Lowest Output on Record.

So far as Clyde shipbuilding is concerned, the output for the month just ended is the lowest ever recorded, amounting, as it does, to only a small motor launch of 15 tons. The second lowest record was in April, 1922, when, as a result of labour trouble in the shipyards, only one vessel of 25 tons was launched. Aggregate returns for this year to date amount to 113 vessels of 256,568 tons, compared with 196 vessels of 492,527 tons in the same period last year. The ending of the coal dispute has brought out a number of fresh contracts, and they, along with existing orders on which very little work has been yet done, should mean considerable activity in the months to come. It is pointed out, however, that many of these contracts are really arrears of work which should have been placed months ago, and that a continuity of orders over the winter is necessary to ensure a revival in trade. New contracts include the following:—Two submarines, a motor oil tanker of 10,000 tons, an oil tanker of 8000 tons, two cargo vessels of 9000 tons and one of 8000 tons, and three steamers of 5800 tons each.

Steel and Iron.

So far as actual business is concerned, there is little change in the steel and iron trades since last week. Arrangements are being considered regarding a resumption of work, but costs are still the determining factor. The prices of fuel are weakening, but are still considerably above the level at which furnaces could be economically re-lit. Some producers with adequate stocks of pig iron are endeavouring to arrange to carry on through the coming holiday season at normal wages rates, while others are disposed to wait until supplies of pig iron are assured before reopening their establishments. Inquiries have been few recently, partly owing to the prices quoted, but many producers have a considerable amount of work on hand to go on with. Steel sheet makers have been well placed all along for business, and prices attained a very firm level, but a slightly weaker tendency is now noticeable. The two bar iron works in operation continue to direct attention chiefly to the production of steel bars manufactured from foreign billets. Bar iron is therefore scarce and comparatively dear. Any business in pig iron is only a matter of odd lots secured from makers' stocks at high prices. It is said that bookings of foreign materials have dropped off in view of probable early supplies of home products. There is no diminution in the export demand for black and galvanised sheets, and a large proportion of the present output is for direct shipment. Deliveries of continental slabs and sheet bars have become most unsatisfactory owing to shipping delays, but that should now improve with the settlement of the coal strike releasing more shipping.

Coal.

Business in the coal market during the past few days shows little change from the preceding week. Demands have increased, but supplies have more than kept pace and prices have gradually weakened accordingly. Apart from increasing household demands, additional business has been done in shipments to Northern Ireland and to the South of England. Screened coal has sold at 35s.; unscreened, 30s.; treble nuts, 35s.; double nuts, 30s. to 32s. 6d.; single nuts, 28s.; pearls, 27s.; and dross, 25s.—all per ton. These prices were upset and the market further unsettled by offerings of Fifeshire fuel at 30s. for best screened, 29s. second qualities, 28s. treble nuts, and 25s. per ton for single nuts. House coal has sold freely at about 40s. to 42s. 6d. per ton at pit, and can be bought retail from 2s. 9d. to 3s. 3d. per cwt. bag, according to district and quality, while coal has also sold at 2s. 7½d. per cwt. in 4 cwt. lots.

The Return to Work.

In practically all districts in Scotland large numbers of miners presented themselves for employment. They will be taken on as conditions warrant. At the moment, the number of men employed is equal to 50 per cent. of the pre-strike total.

Industrial Coal Prices.

While prices of fuel are gradually falling, the weakening process has some distance to travel yet, ere industrial fuel has reached the pre strike levels, which were as follows:—Splint coal, 16s. 6d.; double nuts, 13s. 6d.; and single nuts, 11s.—all per ton at pit.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Agreement Pending.

PROBABLY by the time this letter appears an agreement between the South Wales coalowners and the South Wales Miners' Federation will have been come to. A week ago the prospects were by no means particularly rosy, as the terms for a settlement offered by the coalowners were described by some of the men's leaders as a "dictated" settlement. The report that one of the crucial points had been overcome, viz., that relating to hours, proved to be erroneous, as although the men's side suggested a 7½-hour day, the owners insisted on an 8-hour day for five days of the week, and were prepared to agree to a 7-hour shift on the Saturday for all men employed underground, except continuous shift men. In making that offer, however, the owners required an adequate allowance for amortisation to be charged to costs other than wages, and 3d. per ton was suggested as to the amount of the allowance, or, alternatively, the fixing of the ratio of distribution of proceeds at 85 per cent. and 15 per cent. Apart from the question of hours, the discussion between the parties centred mostly round the question of reinstatement. The representatives of the men on the Conciliation Board subsequently conveyed to their executive the terms put forward by the owners, and on Friday, at a conference of delegates from the coalfield, the recommendation submitted by the executive was adopted, this being that the workmen should be asked to ballot upon the question of giving authority to the Executive Council again to meet the coalowners and negotiate a settlement. This ballot was taken during the past week-end, and although no figures have been disclosed at the time of writing, it is reported that the majority in favour of the Committee's recommendation is over 40,000. Scarcely anyone can, however, claim that a proper ballot was taken. Reports from the various districts show that in some cases a decision was taken by a show of hands at a mass meeting of the workmen, while it is alleged that in some areas those miners who had resumed work were not allowed to vote. In other cases those who took part in the ballot did not represent 10 per cent. of the total number of men employed at the collieries concerned. At any rate, it was evident to the leaders that the voting was going in favour of the executive making a settlement, and, in addition, the fact could not be ignored that increasing numbers of workmen were returning to work. On Monday there were 6000 more men at the pits than was the case at the end of last week. The coalowners were therefore asked to meet a sub-committee of the miners' executive on Tuesday afternoon, this being the day when the voting returns from the coalfield had to be in. This meeting took place, and it is understood that such terms as were agreed upon would, subject to the approval of the full executive, be the basis upon which the members of the Federation would resume work throughout the coalfield.

LATER.

After about five hours' negotiations, terms of an agreement were arranged between the representatives of the coalowners and miners late on Tuesday evening. The end came with rather dramatic suddenness, and the strike was called off, it being arranged that instructions should be issued for a resumption of work on Wednesday night by the night men and by the hewers and surfacemen on Thursday. Anticipating the end, 9500 more miners resumed work on Tuesday, as compared with Monday, bringing the total to over 51,000. On Wednesday the men were flocking back to work. The agreement come to is for three years. An eight-hour shift is to operate on five days and a seven-hour shift on Saturdays. Pre-stoppage wages of 42·22 per cent. on the 1915 standard rates are to be paid till the end of next May, after which the general wage rate will be governed by the proceeds of the industry, subject to a minimum wage of 28 per cent. on the 1915 standard rates. The distribution of the net proceeds of the industry are to be in the ratio of 85 per cent. to wages and 15 per cent. to profits.

Coal Prices.

The price of coals for household consumption has been reduced to 40s. per ton at the pithead for large coals.

Getting to Business.

The improving outlook has, of course, stimulated interest in business, and everyone is endeavouring to set the wheels of commerce in motion again, but it is a rather hard and slow process. The output has increased, and so far has amounted to about 4000 tons per day in the case of one large undertaking. Great efforts are being made to secure the release of coals for export, but up to the moment of writing success in this direction has not been achieved; but shipments can be made without any restriction to any port in the United Kingdom, Ireland and the Channel Islands, and coals can be obtained freely for the bunkering of steamers for any voyage. A few steamers have been chartered for French, Spanish, Portuguese and other ports with readiness next week in anticipation that the authorities will release coals for cargoes by that time. Exporters are confident that the authorities will have to give way, otherwise collieries will be interrupted in their working, owing to the shortage of wagons. Although nothing definite has been announced, it is reported that the authorities intend bringing into operation the system of permits, so that applications for release will be considered and granted as the position justifies. Notwithstanding the home demand there is undoubtedly a larger supply of coal available, and whereas recently prices were quoted at 45s. for large, 40s. for through, and 35s. for smalls, business has been done at 37s. 6d. for large and even less, but small coals are relatively more scarce, and are still quoted round about 30s. to 35s. per ton. It is expected that as soon as the men get back to work on anything like a general scale, which is expected to be on Monday next, prices will mark a further fall. Exporters hold a fair number of orders, but many foreign buyers are holding off for the moment. There is an unconfirmed report on the market that the French State Railways have purchased about 100,000 tons of Welsh coals for delivery over the first half of next year.

Big Welsh Colliery Deal.

Since I wrote last week an important colliery deal has been carried through. The company known as Ocean Coal and Wilsons, Ltd., has acquired a controlling interest in the United National Collieries, Ltd., by the purchase of the necessary proportion of ordinary shares in the latter concern at a price of 26s. 6d. per share. The transaction involves a sum of over one million pounds. The directors of the United National Company have resigned, and a new board has been appointed, with Mr. David Davies as chairman and Mr. Thomas Evans as managing director, these two gentlemen holding the same positions in Ocean Coal and Wilsons, Ltd. The United National Company will continue to retain its separate identity in name and as a company, but the sale of its coals will be passed over to the Ocean Company. The combined capital of the two undertakings amounts to nearly 8½ millions, including debenture and share capital, and the annual output of coals from the collieries of the two concerns runs to over 5,000,000 tons. The news of this fusion has caused very considerable interest in coal trade circles, and there are already rumours of further important developments in regard to other big undertakings.

Break from Federation.

The workmen engaged at the Taff-Merthyr Colliery, Trelewis, recently decided to make a break with the South Wales Miners' Federation and to form a separate organisation of their own. At a meeting on Saturday last they decided to call their new organisation the "South Wales Miners' Industrial Union." Draft rules have been framed, and the committee responsible has been recognised by the management of the colliery, which is a joint undertaking of the Ocean Coal Company and the Powell Duffryn Steam Coal Company. It is estimated that in time this colliery will employ about 2000 workmen. It is also reported that some of the miners in the anthracite area are breaking away from the Federation with a view to setting up a rival organisation.

Engineering Exhibition.

A most successful exhibition of engineering plant, &c., organised by the South Wales Institute of Engineers, was opened on Wednesday of last week by Mr. David Hannah, the President of the Institute, and remained open this week. The Exhibition was held in the Drill Hall at Cardiff, and has been of especial interest to those engaged in the mining industry. It was well attended every day. The most was made of the accommodation available, but it illustrates the success of the undertaking and the value placed upon it by manufacturers that 60 per cent. of the exhibitors were represented at previous exhibitions. Twice as many exhibits could have been staged had the accommodation been available, and in order to impress upon the civic authorities the need and value of a larger hall in the city, the promoters of the Exhibition invited members of the Cardiff Development Committee to visit the display on Tuesday. The Council of the Institute has conferred the highest distinction in its power, viz., honorary membership, upon Mr. W. D. Wight and Mr. David E. Roberts, in recognition of the services rendered by the former generally to the Institute and to the coal trade in South Wales over a long period of years, and to the latter in appreciation of his activities in promoting the exhibitions since their initiation in 1921.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	18/6 to 21/-
(1) Spanish	18/6 to 21/-
(1) N. African	18/6 to 21/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	—

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	—	—
No. 1 Foundry	‡4 15 0 to 5 0 0	—
No. 3 Foundry	‡4 10 0	—

‡ *For delivery after resumption of work at furnaces.*

N.E. COAST—		
Hematite Mixed Nos.	*No quotation.*	
No. 1	„ „	
Cleveland—		
No. 1	6 5 0	6 5 6
Silicious Iron	6 5 0	6 5 6
No. 3 G.M.B.	6 0 0	6 0 6
No. 4 Foundry	5 19 0	5 19 6
No. 4 Forge	5 18 6	5 19 0
Mottled	5 17 6	5 18 0
White	5 17 6	5 18 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
„ „ Foundry	4 7 6	—
(3) Northampton—	*(None offered.)*	
Foundry No. 3	3 5 0 to 3 10 0	
„ Forge	2 16 0 to 2 17 0	
(3) Derbyshire—	*(None offered.)*	
No. 3 Foundry	3 7 6 to 3 15 0	
Forge	3 2 0 to 3 5 0	
(3) Lincolnshire—	*(None offered.)*	
No. 3 Foundry	3 5 0	—
No. 4 Forge	3 5 6	—
Basic	3 6 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 15 6 (a) / 4 18 6 (b) / 5 2 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	12 0 0	11 0 0
Best	—	—
N.E. COAST—		
Common Bars	11 15 0	—
LANCS.—		
Crown Bars	12 10 0	—
Second Quality Bars	11 5 0	—
Hoops	14 0 0	—
S. YORKS.—		
Crown Bars	12 10 0	—
Best Bars	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—	*(Prices nominal.)*	
Crown Bars	11 5 0 to 11 10 0	
Marked Bars (Staffs.)	14 0 0	—
Nut and Bolt Bars	10 5 0 to 10 10 0	
Gas Tube Strip	12 10 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	11 0 0	—
Ship Plates, ¼in. and up *d*	8 2 6	7 0 0
Sections	7 12 6	6 5 0
Steel Sheets, under $^{3}/_{16}$in. to ¼in.	12 0 0 to 13 0 0	
Sheets (Gal. Cor. 24 B.G.)	— £17 10 0 to 18 10 0	

(*d*) *Official Minimum, actual prices about 5s. more.*

STEEL (*continued*).

N.E. COAST—	Home. £ s. d.	Export. £ s. d.
Ship Plates	8 12 6	—
Angles	8 12 6	—
Boiler Plates	12 0 0	—
Joists	8 0 0	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 0 0†	—
Light Rails	8 5 0 to 8 10 0	
Billets	8 0 0 to 11 10 0†	
MANCHESTER—		
Bars (Round)	9 10 0	—
„ (Small Round)	10 0 0	—
Hoops (Baling)	11 0 0	11 0 0
„ (Soft Steel)	10 15 0	10 15 0
Plates	8 15 0 to 9 0 0	
„ (Lancs. Boiler)	11 15 0	—
SHEFFIELD—		
Siemens Acid Billets	11 0 0	—
Bessemer Billets	11 0 0	—
Hard Basic	9 2 6	—
Intermediate Basic	8 12 6	—
Soft Basic	7 15 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 10 0	—
MIDLANDS—		
Small Rolled Bars	8 15 0 to 9 5 0	
Billets and Sheet Bars	—	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	17 5 0 to 17 10 0	
Angles	8 12 6 to 8 17 6	
Joists	8 12 6 to 8 17 6	
Tees	9 12 6 to 10 17 6	
Bridge and Tank Plates	—	
Boiler Plates	—	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	23/3 to 25/3
Block Tin (cash)	317 0 0
„ (three months)	300 15 0
Copper (cash)	56 10 0
„ (three months)	57 5 0
Spanish Lead (cash)	29 0 0
„ (three months)	29 5 0
Spelter (cash)	33 11 3
„ (three months)	33 11 3
MANCHESTER—	
Copper, Best Selected Ingots	64 5 0
„ Electrolytic	64 17 6
„ Strong Sheets	92 0 0
„ Tubes (Basis Price) lb.	0 1 1
Brass Tubes (Basis Price) lb.	0 1 0
„ Condenser lb.	0 1 2½
Lead, English	30 10 0
„ Foreign	29 7 6
Spelter	33 10 0
Aluminium (per ton)	£107

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/9½ to 1/10½ per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/6
„ „ 6 p.c. to 8 p.c. „	£22 0 0	7/3
„ „ 8 p.c. to 10 p.c. „	£20 15 0	6/6
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£37 0 0	12/6
„ „ „ 1 p.c. „	£43 0 0	15/-
„ „ „ 0·70 p.c. carbon	£54 0 0	17/6
„ „ „ carbon free	1/5d. per lb.	
Metallic Chromium	3/- per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 5 0 scale 5/- per unit	
„ „ 75 p.c.	£17 10 0 scale 6/- per unit	
„ Vanadium	14/3 per lb.	
„ Molybdenum	5/- per lb.	
„ Titanium (carbon free)	0/11½ per lb.	
Nickel (per ton)	£170	
Cobalt	8/6 per lb.	

FUELS.

SCOTLAND.

LANARKSHIRE— (*Prices nominal.*)	Export.
(f.o.b. Glasgow)—Steam	15/9
„ „ Ell	16/6
„ „ Splint	16/6 to 17/-
„ „ Trebles	15/9
„ „ Doubles	14/- to 14/6
„ „ Singles	13/9
AYRSHIRE—	
(f.o.b. Ports)—Steam	16/9
„ „ Jewel	17/- to 17/6
„ „ Trebles	17/-
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	12/6 to 14/9
Screened Navigation	21/-
Trebles	14/- to 15/-
Doubles	14/-
Singles	13/- to 13/6
LOTHIANS—	
(f.o.b. Leith)—Best Steam	14/- to 14/3
Secondary Steam	13/6
Trebles	14/6 to 14/9
Doubles	13/6
Singles	13/6

ENGLAND.

(8) N.W. COAST—	
Steams	*No quotation.*
Household	„
Coke	„
NORTHUMBERLAND—	
Best Steams	32/6
Second Steams	30/-
Steam Smalls	24/-
Unscreened	30/-
Household	35/-
DURHAM—	
Best Gas	30/-
Second	27/-
Household	35/-
Foundry Coke	—

SHEFFIELD—	Inland. (*Nominal, none on offer.*)
Best Hand-picked Branch	31/- to 34/- —
Barnsley Best Silkstone	28/- to 30/- —
Derbyshire Best Brights	26/- to 28/- —
„ „ House	24/- to 25/- —
„ „ Large Nuts	17/- to 20/- —
„ „ Small	12/6 to 14/- —
Yorkshire Hards	17/- to 19/6 —
Derbyshire Hards	16/- to 19/- —
Rough Slacks	10/- to 12/6 —
Nutty Slacks	7/6 to 9/- —
Smalls	3/6 to 6/- —
Blast-furnace Coke (Inland)*	— —
„ „ (Export) f.o.b.	16/- to 17/-

(9) SOUTH WALES.

CARDIFF— Steam Coals: (*All prices nominal.*)	
Best Smokeless Large	35/- to 40/-
Second „ „	30/- to 35/-
Best Dry Large	30/- to 40/-
Ordinary Dry Large	30/- to 35/-
Best Black Vein Large	30/- to 35/-
Western Valley Large	30/- to 35/-
Best Eastern Valley Large	30/- to 35/-
Ordinary „ „	30/- to 35/-
Best Steam Smalls	25/- to 30/-
Ordinary „	20/- to 22/6
Washed Nuts	19/- to 26/-
No. 3 Rhondda Large	35/- to 40/-
„ „ Smalls	2[illegible]/- to 25/-
No. 2 „ Large	30/- to 32/6
„ „ Through	25/- to 27/6
„ „ Smalls	20/- to 25/-
Foundry Coke (export)	40/- to 50/-
Furnace Coke (export)	25/- to 30/-
Patent Fuel	35/- to 40/-
Pitwood (ex ship)	42/6 to 45/-
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	39/- to 40/-
Seconds	32/6 to 35/-
Red Vein	27/- to 29/-
Machine-made Cobbles	47/6 to 50/-
Nuts	47/6 to 50/-
Beans	42/6 to 44/-
Peas	23/- to 25/-
Breaker Duff	7/6 to 8/-
Rubbly Culm	12/6 to 13/6
Steam Coals:	
Large	22/6 to 24/6
Seconds	20/- to 22/-
Smalls	11/- to 15/-
Cargo Through	16/6 to 17/6

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 17/-, with fluctuations according to analysis; open market 17/6 to 19/- at ovens. † Latest quotations available. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Steel Production and Costs.

THE steel production during October totalled 741,748 tons, which is a record for any single month, the previous highest being 726,000 tons in March last. In the first ten months of the year the production was 6,189,399 tons. In October also the total quantity of pig iron produced was 815,694 tons, which exceeded the previous highest total in August last by about 2000 tons. The number of furnaces in blast was 154, while 32 were ready to be put in blast and 31 were under construction or repair. This result must be attributed largely to the very heavy contraction in the steel production in Great Britain, and the question now arising is what will follow on the termination of the miners' strike? The expansion was also, of course, partly due to the export facilities offered by the low value of the franc. So far as the currency is concerned, there has lately been some stabilisation, which, however, cannot be taken into account for future negotiations, and while the export business has certainly been checked, it is feared that any further accession of foreign orders will be rendered more difficult by the competition of British steel makers. At the same time the reopening of the collieries is regarded with a feeling of relief by iron and steel producers, who find that their partial dependence on German supplies of fuel is causing them some embarrassment. Notwithstanding the considerable increase in the home production of coke during the past few years, consumers still have to rely upon Germany for about a third of their requirements, and, since the Germans found themselves free to fix their own prices for the French market, those prices have been steadily advancing. Now that a further rise of 3 or 4 marks a ton is almost certain to be imposed, the French consumer finds that the situation is becoming serious, especially in view of the higher value of the franc, and he is therefore looking to Great Britain for supplies of coal and coke which will check this upward movement.

Colliery Equipment.

The repairing of the damage done during the war to the collieries in the Nord and the Pas de Calais is one of the greatest undertakings the French have successfully carried through. When the coalowners were able to take stock of their properties the situation appeared almost hopeless, but starting all over again, the owners were able to put down all that was best in the way of colliery equipment. The results obtained were shown by means of lantern projections at a recent meeting of the Société des Ingénieurs Civils, when an account was given of the installation at each of the leading collieries. Plants have been laid down in accordance with the most approved modern practice. All the buildings are of reinforced concrete, and each colliery has its electrical power plant, all the collieries being connected up electrically throughout the entire region. British types of steam generators are employed almost everywhere. Labour-saving equipments are installed wherever possible. At Anzin the boilers are fired with pulverised anthracitic coal, and at some of the other collieries, where bituminous coal is raised, the use of pulverised fuel is giving good results. The use of coal-cutting machinery is limited by the character of the seams, but, nevertheless, such machines are largely employed, and they are partly responsible for the considerable increase in the production of coal. In the Nord and the Pas de Calais the production increased from 27 million tons a year in 1913 to 32 million tons at the present time. Illustrations shown on the screen of some of the coke ovens conveyed an impressive idea of the way in which French coalowners are seeking to remedy the shortage of coke supplies. At the Lens colliery the coke ovens are supplying gas for four internal combustion engines of the M.A.N. type, each of 2500 horse-power.

Continuous Brakes.

The International Brake Commission is to meet in Paris at an early date with a view of coming to a final decision concerning the equipment of goods trains on the Continent with continuous brakes. At present there are only two systems recommended, the Westinghouse and the Kunze-Knorr, and the situation becomes somewhat complicated by the fact that while the French carried out interminable tests with different brake systems, the Germans made considerable headway with the practical application of the K.K. brake, which was actually fitted to many thousands of vehicles during the war. The use of the German brake has become general in Central Europe, and is regarded with favour in Scandinavia, Switzerland and Italy. This activity of the Germans in getting their brake so largely adopted is declared to be contrary to the spirit of the Berne Convention, as well as of the Treaty of Versailles, but apparently nothing can be done now beyond finding some compromise whereby any alternative brake may be interchangeable with the K.K. Even then the battle of the brakes is not likely to be settled, for Messrs. Schneider et Cie., are introducing a continuous brake designed on principles described by Monsieur Drosne at a recent meeting of the Société des Ingénieurs Civils. In the opinion of Monsieur Drosne the compressed air brake does not fulfil all the required conditions. The vacuum brake is, he said, more powerful and more rapid in action, and he claims for the new brake that it combines the advantages of both.

Suburban Electrification.

The electrification of the Paris suburban railways is being retarded by the financial disabilities, but it is stated that the electrical installation of the Paris–St. Germain line will be terminated at the beginning of March, while the Versailles–Sait-Nom-la-Bretèche line will be completed in 1928. Having failed in their negotiations to dispose of the Auteuil electrified line to the Metropolitan Railway Company, the State Railways propose to hand it over gratuitously, on condition that the Metropolitan Company will connect it up at Pont Cardinet with the Metropolitan system.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

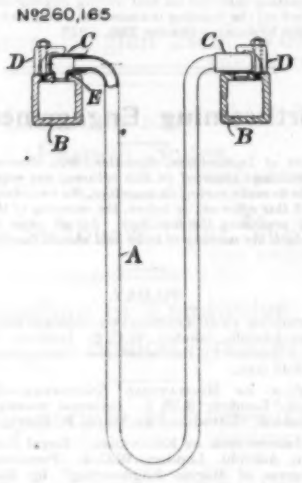
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

260,165. April 6th, 1926.—SECURING TUBES IN HEADERS. A. H. Spearing and W. R. Hamlyn, 3, Clement's-inn, Westminster.

In this superheater the U tubes A are connected with the headers B B by means of right-angle unions C C which are held down by the clamps D D. The joint is made tight by the washer E. By adopting this arrangement any U tube can be replaced

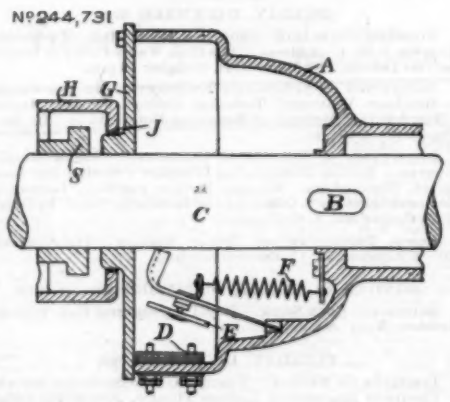


without disturbing the others, or even only one end of any tube can be unfastened separately. In order to obviate the liability for the tube to crack at the end of the thread used to fix it in the union, the bore of the union is bell-mouthed and the length of the screwed port of the tube is such that it goes wholly within the bell mouth.—*October 28th*, 1926.

DYNAMOS AND MOTORS.

244,731. November 17th, 1925.—IMPROVEMENTS IN AND RELATING TO EXPLOSION-PROOF CENTRIFUGAL SWITCHES FOR STARTING INDUCTION MOTORS, Aktiengesellschaft Brown, Boveri et Cie., of Baden, Switzerland

The centrifugal starter constructed in accordance with the invention is illustrated in the accompanying drawing. The pot-shaped housing A is secured at B on the shaft C, and contains

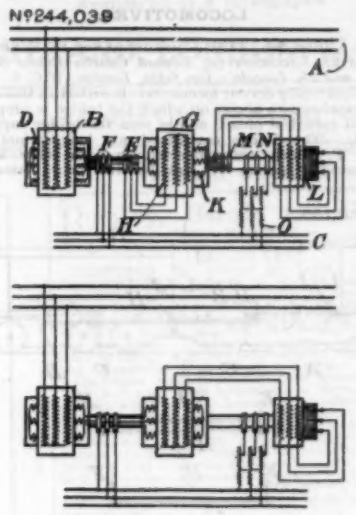


the fixed contact D and a movable contact E under the control of a spring F. The open side of this pot-shaped housing is closed by a cover G, which forms the front of the housing A. H is the stationary pedestal body between which and the body of the rotor—not shown—the starter is mounted. S is the bushing and J a felt packing between the bearing and the cover G of the housing.—*October 21st*, 1926.

TRANSFORMERS AND CONVERTERS.

244,039. May 19th, 1925.—IMPROVEMENTS IN OR RELATING TO DYNAMO-ELECTRIC MACHINES FOR FREQUENCY CONVERSION, Siemens-Schuckertwerke Gesellschaft mit beshränkter Haftung, of Berlin-Siemensstadt, Germany.

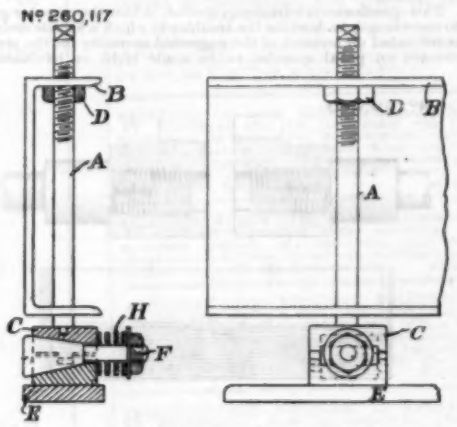
In the diagram A is a three-phase circuit having a frequency of, say, 50 cycles per second. B is the principal machine of the frequency changer, with primary and secondary windings, the latter being connected to slip rings and feeds on the second circuit C in which another frequency is required. The rotor is also provided with a second winding D, which is connected to the first winding and with a second set of slip rings E, which, if required, could also be combined with the set of slip rings F. The second set of slip rings could be eliminated altogether if, as shown in the lower illustration, the rotor of the load machine be fed from the principal machine. The load machine G has a winding H connected through the slip rings E to the winding D of the principal machine and a winding K. A three-phase current exciter machine L is connected in the manner shown through slip rings M. The field of the machine L is excited at the network frequency, the slip rings N being connected through the adjustable transformer O to the circuit C. By regulation of the voltage value and phase on this transformer the value and phase of the tension of the circuit C can be adjusted at will, or if this circuit has already a different frequency through other machines



the phase could be regulated. The number of revolutions of the frequency converter can also be brought to given values by means of this arrangement.—*October 19th*, 1926.

260,117. November 26th, 1925.—IMPROVEMENTS IN AND RELATING TO ELECTRIC TRANSFORMERS, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2, and Allan Adair Pollock, of Croxton House, Sherborne-place, Leamington Spa.

In this specification an arrangement is described for taking up the shrinkage of the insulation of transformer coils or the shrinkage of struts between reactor coils. A represents a rod passing through holes in flanges B projecting from the core side plate of a transformer. The lower end of this rod bears on the upper side of a split shoe C, pressure being applied to the shoe by screwing the nut D on a screwed portion of the rod against

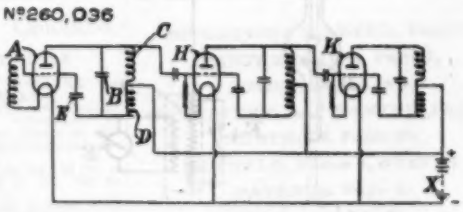


the underside of the flange B. The shoe C rests on the upper side of a pressure distributing flange E supported on the coil stack, which is not shown. The shoe C is split longitudinally and is provided with a rectangular tapered slot in which a tapered bolt or cotter is adapted to slide. The cotter is provided with a screwed part F, which is provided with a nut. A helical spring H surrounds the pin F and is adapted to be compressed between the nut and the shoe C. If any downward movement of the distributing flange E occurs as a result of shrinkage of the coils the spring H automatically pulls the cotter pin further into the tapered slot in the shoe, thereby maintaining the pressure on the coils substantially constant.—*October 28th*, 1926.

TELEGRAPHS AND TELEPHONES.

260,036. July 20th, 1925.—IMPROVEMENTS IN OR RELATING TO THERMIONIC AMPLIFIERS AND THE LIKE, Henry Joseph Round, of 9, Woodberry-crescent, Muswell Hill, London, N.

The object of the inventor is to provide an amplifier in which the effect of reaction and/or undesired coupling attributable to the inter-electrode capacity is avoided. In the anode circuit of the valve A there is an anode condenser B and an anode inductance composed of two balanced parts C D. E is a balancing condenser connected to the grid of the valve A and has a value which compensates for the self-capacity of the valve. The anode



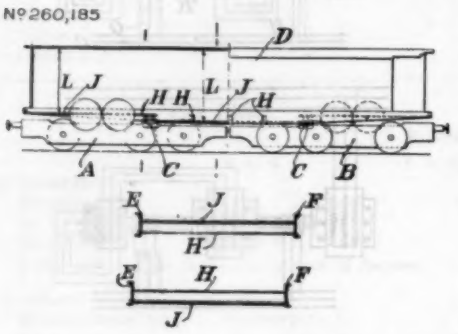
circuit is completed through the anode battery X from a point between the two parts on the last anode inductance the circuits of the valves H K being arranged in a similar manner to the first valve A as shown. The anode inductance of the valve A is wound to be astatic; that of the valve H non-astatic; and that of the valve K astatic. In the diagram only such parts as are necessary to explain the invention have been shown, the filament battery and its associated connections having been omitted. The anode inductances required to be astatic may be formed in two parts wound in the opposite sense, so that the mutual inductance of each part with respect to the remainder of the

apparatus is in the opposite sense to that of the other half. The astatic coils must, of course, have as a whole sufficient inductance to serve as anode inductances.—*October 20th*, 1926.

LOCOMOTIVES.

260,185. June 9th, 1926.—IMPROVEMENTS IN ELECTRICALLY DRIVEN LOCOMOTIVES, *Edward Charles Robert Marks, of 57 and 58, Lincoln's Inn-fields, London, W.C. 2.*

The electrically driven locomotive described in this specification comprises two bogies on which the bridge is supported by means of spherical pins C and in turn the bridge supports the body D. The bridge comprises two longitudinal bearers E and F, which are connected to each other by means of transverse bearers H and by the floor plates J. In

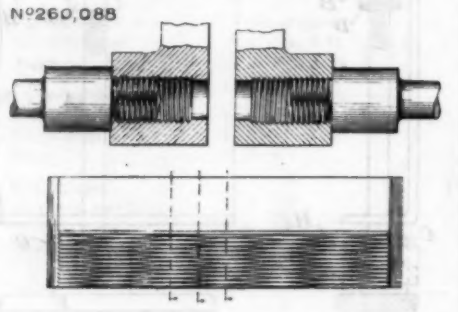


the middle part of the bridge the floor plate J is arranged below the cross bearers H, whilst in the end parts of the bridge the floor plate J is arranged above the cross bearers as shown. The floor plate in the middle part of the bridge gives an increase in the height L for pacing the electrical apparatus. The cross beams in the middle part may be so distributed that they may directly serve as supports for the electrical apparatus and machinery, thus avoiding the use of other girders for that purpose. The space between the cross bearers is available for housing cables, which are well protected.—*October 28th*, 1926.

MACHINE TOOLS AND SHOP APPLIANCES.

260,088. September 28th, 1925.—ROLLING SCREW THREADS. J. H. Graham, 75, John-street, Torrington, Connecticut, U.S.A.

This specification is distinctly quaint, in that the inventor goes to some length to describe the troubles to which a bicycle erector is subjected on account of the suggested necessity for the screw threads on pedal spindles to be made right or left-handed

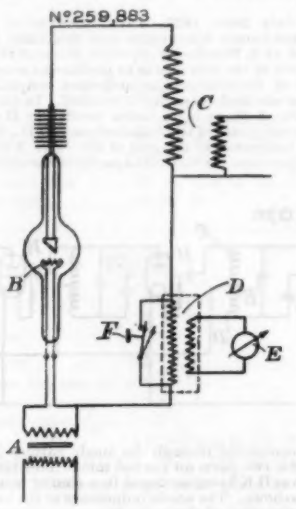


according to which crank they belong. He consequently threads the shank of the spindle with intersecting right and left-hand threads, so that any spindle can be screwed into either form of crank. The threads are formed by the rolling process and the rolling dies are made by being rolled over and under a master double-screwed plug and hardened subsequently.—*October 28th*, 1926.

MISCELLANEOUS.

259,883. August 11th, 1925.—IMPROVEMENTS IN DEVICES FOR MEASURING ELECTRIC CURRENTS IN RÖNTGEN RAY TUBES AND THE LIKE, Dr. Gerhard Freiherr du Prel, of 50, Barerstrasse, Munich.

For measuring the current of a Röntgen ray tube, it is usual



to employ milliampère meters, but when the tube is used with high-frequency currents, this type of measuring instrument is useless, because the inductance of the measuring coil has a choking effect. The method of measuring the current in accordance with this invention is shown in the accompanying diagram, where A is the transformer which supplies heating current to the cathode B. C is a Tesla transformer with primary and secondary coils connected together at one end, as shown. There is also another transformer at D, the secondary winding of which is connected to a hot wire ammeter E. The windings of this transformer have a ratio of 1 : 10, so that a maximum current of 50 milliampères in the primary coil will produce a current of 500 milliampères in the secondary coil. To protect the instrument from overload, when, for instance, sparking occurs in the tube, the primary coil is normally short-circuited by a connection which includes a spring-supported break operated by a key F, which when depressed causes the transformer D to be excited when the current can be read on the instrument E. The lowest measurable tube current is 5 milli-ampères.—*October 21st*, 1926.

260,156. March 22nd, 1926.—A SELF-LUBRICATING BEARING, A. Hewlett, The Cossall Colliery Company, Ltd., Ilkeston, Derby, and H. Cooper, 47, Kilnhurst-road, Rotherham.

This invention relates to a self-lubricating bearing for use with all classes of machinery, engines, but more particularly for use with pit tub pedestals. Such a bearing consists of wood, preferably hornbeam, which has been immersed in and impregnated or saturated with oil. In carrying out the invention a bearing is immersed in oil, the oil being steam heated, whereby the immersed bearing is subjected to impregnation or saturation so that in use the bearing is constantly and automatically lubricated by its own reserve of oil. Preferably the bearing is inserted into position in its housing before impregnation and immersed with the housing into the oil and during impregnation with the steam heated oil the bearing is caused to swell and make a tight fit within the housing.—*October 28th*, 1926.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF FUEL TECHNOLOGY.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Lecture, "The Loss of Heat from a Surface by Radiation and Convection," by Dr. T. Barratt. 5.45 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, London, S.W. 1. Informal meeting. "Industrial Ventilation," introduced by Mr. A. E. Harris. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Presidential address, "The Progress of Marine Engineering," by Engineer Vice-Admiral Sir Robert B. Dixon. 7.30 p.m.

TO-DAY AND SATURDAY, DECEMBER 4TH.

UNIVERSITY OF LONDON.—University College, Gower-street, London, W.C. 1. Engineering Exhibition and Soirée.

SATURDAY, DECEMBER 4TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—College of Technology, Manchester. Paper, "The Commercial Aspect of the Foundry," by Mr. J. Wolstenholme. 4 p.m.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—Visit to the Hockley Valley sewer and parts of the Hockley Brook works, Birmingham. 10.45 a.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Shire Hall, Hertford. South Midland District meeting. 10.45 a.m.

THE ROYAL INSTITUTION.—21, Albemarle-street, London, W. 1. Lecture, "Atmospheric Electricity," by Mr. George C. Simpson. 3 p.m.

MONDAY, DECEMBER 6TH.

ECONOMIC RESEARCH GROUP.—Caxton Hall, Westminster, London, S.W. 1. Address, "The High Wages Policy in Industry and its Defects," by Major C. H. Douglas. 6 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: BRISTOL CENTRE.—Merchant Venturers' Technical College, Bristol. Lecture, "The L.G.O.C. Methods of Repairing Motor 'Buses," by Mr. G. Rushton. 6.45 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SOUTH MIDLAND CENTRE.—British Broadcasting Company's Studio, 282, Broad-street, Birmingham. Wireless Section meeting. Lecture and demonstration on "Distortion in Receiving Sets," by Messrs. J. A. Cooper and A. C. Chatwin. 7 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. General meeting. 5 p.m.

MONDAY TO FRIDAY, DECEMBER 6TH TO 10TH.

SMITHFIELD CLUB SHOW.—Royal Agricultural Hall, Islington, London, N. 1. 9 a.m. each day.

TUESDAY, DECEMBER 7TH.

INSTITUTE OF METALS: NORTH-EAST COAST LOCAL SECTION.—Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-upon-Tyne. "Foundry Work," by Mr. A. Logan. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2 Paper, "The Use of the Optical Indicator as a Means of Examining Combustion in Internal Combustion Engines," by Professor W. Morgan. 7 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Broadgate Café, Coventry. Coventry Graduates' meeting. Paper by Mr. J. N. H. Tait. 7.15 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—Electrical Engineering Lecture Room, No. 149. Royal Technical College, Glasgow. Lecture, "Home Lighting," by Mr. R. B. Mitchell. 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SOUTH MIDLAND STUDENTS' SECTION.—The University, Edmund-street, Birmingham. Paper, "The Windings of Electrical Machinery," by Mr. L. Greenwood. 7.15 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "The Imperfect Crystallisation of Common Things," by Sir William Bragg. 5.15 p.m.

WEDNESDAY, DECEMBER 8TH.

INSTITUTE OF PHYSICS.—Institution of Civil Engineers, Great George-street, London, S.W. 1. Lecture, "Physics in Navigation," by Mr. F. E. Smith. 5.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, London, S.W. 1. Informal Meeting. Discussion on "The Circumstances in which Small Private Electric Generating Stations may have Advantages Over Public Stations," introduced by Mr. A. H. Dykes. 6 p.m.

INSTITUTION OF ENGINEERS-IN-CHARGE.—St. Bride Institute, Bride-lane, Fleet-street, London, E.C. 4. Paper, "Some Notes on Accurate Measurement," by Mr. C. H. Penn. 7.30 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "The Port of Antwerp," by Rev. Père De Cleyn. 8.30 p.m.

WEDNESDAY TO FRIDAY, DECEMBER 8TH TO 10TH.

INSTITUTION OF CHEMICAL ENGINEERS.—Science Museum, South Kensington, London, S.W. 7. Conference. For programme see page 580.

THURSDAY, DECEMBER 9TH.

INSTITUTE OF METALS: LONDON LOCAL SECTION.—Society of Motor Manufacturers' and Traders' Rooms, 83, Pall Mall, London, S.W. 1. Joint meeting with the Institute of British Foundrymen. "Contraction and Alloy Casting," by Mr. H. C. Dews. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Co-operative Old Hall, Derby. Derby Graduates' meeting. Exhibition of films. 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Connaught Rooms, Great Queen-street, London, W.C. 2. Annual dinner. 6.45 for 7.15 p.m.

SOCIETY OF TECHNICAL ENGINEERS: MANCHESTER AREA.—Church Institute, Stretford, Manchester. Address on "The Electricity Supply Bill," by Mr. J. W. Thomas. 8 p.m.

FRIDAY, DECEMBER 10TH.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—Applied Science Department of the University, St. George's-square, Sheffield. "The Conductivity of Silver Plating Solutions," by Mr. A. E. Nicol. 7.30 p.m.

INSTITUTE OF METALS: SWANSEA LOCAL SECTION.—Metallurgical Department, University College, Singleton Park, Swansea. "The Application of Metallographic Methods to Coal," by Mr. C. A. Seyler. 7.15 p.m.

INSTITUTION OF ENGINEERING INSPECTION.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "Portable Steel Structures of Large Span," by Major H. N. Wylie. 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, Westminster, London, S.W. 1. Fifth report of the Marine Oil Engine Trials Committee. 6 p.m.

INSTITUTION OF WATER ENGINEERS.—Geological Society's Rooms, Burlington House, Piccadilly, London, W. 1. Winter general meeting. Papers: "Water Supply Finance," by Mr. A. W. Kenyon; "Recent Developments in the Design and Application of Centrifugal Pumps," by Mr. J. P. Hallam; "Repair Works in Connection with the Belmont Reservoir of the Bolton Corporation," by Mr. J. K. Swales; "The History of an Artesian Bore-hole," by Mr. E. J. Silcock. 10.30 a.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Lecturette, "A Method of Measuring Temperatures in the Cylinders of Internal Combustion Engines," by Mr. C. E. Foster. 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Literary and Philosophical Society's rooms, Newcastle-upon-Tyne. "Workshop Methods in Heavy Engineering," by Messrs. H. J. Brackenbury and W. J. Guthrie. 6 p.m.

SATURDAY, DECEMBER 11TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Vestry Hall, Dawlish. South-Western District meeting. Paper, "Twenty Years in an Urban District," by Mr. S. F. C. Church ward. 2.15 p.m.

MONDAY, DECEMBER 13TH.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "Fescolising," by Mr. C. H. Faris; "Calorising," by Mr. N. C. Marples; and "Chromium Plating," by Mr. E. A. Ollard. 7.30 p.m.

RAILWAY CLUB.—25, Tothill-street, London, S.W. 1. Paper, "The Underground Railway," by Mr. W. H. R. Dawson. 7.30 p.m.

TUESDAY, DECEMBER 14TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH, BURNLEY SECTION.—Municipal College, Ormerod-road, Burnley. Open discussion on short papers by Messrs. J. Hogg, W. H. Meadowcroft and F. Harris. 7.15 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: COVENTRY CENTRE.—Works of Armstrong-Siddeley Motors, Ltd., Parkside, Coventry. Lecture, "The L.G.O.C. Methods of Repairing Motor 'Buses," by Mr. G. Rushton. 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—Electrical Engineering Lecture Room, 149, Royal Technical College, Glasgow. Paper, "The Design of City Distribution Systems and the Problem of Standardisation," by Messrs. J. R. Beard and T. G. N. Haldane. 7.30 p.m.

WEDNESDAY, DECEMBER 15TH.

ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY.—Northampton Polytechnic Institute, St. John-street, London, E.C. 1. "Acidity of Certain Plating Solutions," by Mr. A. W. Hothersall. 8.15 p.m.

SOCIETY OF TECHNICAL ENGINEERS: LONDON AREA.—102, Belgrave-road, London, S.W. 1. Address on "The Present Status and Position of Technical Engineers in Russia." 7.30 p.m.

THURSDAY, DECEMBER 16TH.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—The Engineers' Club, Waterloo-street, Birmingham. "Hardening," by Dr. W. Rosenhain. 7 p.m.

THE LEIPZIG INTERNATIONAL INDUSTRIES FAIR, 1927.—A special section for British exhibitors has been arranged at the Ring Messhaus for the next Leipzig International Industries Spring Fair, which takes place from March 6th to 12th, 1927. Inquiries regarding the Fair should be addressed to the hon. organising secretary, 1, Gower-street, London, W.C. 1.

INSTITUTION OF NAVAL ARCHITECTS.—The following scholarships in naval architecture will be offered for competition in 1927:—Institution of Naval Architects Scholarship, £130 per annum; Vickers Scholarship, £150 per annum; J. S. White Scholarship, £100 per annum; and the two Denny Scholarships, one in Naval Architecture and one in Marine Engineering, each of the value of £75 per annum, and open to boys—British subjects—from approved public or secondary schools. The I.N.A., Vickers and J. S. White scholarships are tenable, subject to the regulations governing each scholarship, at Glasgow University (four years), Durham University (Armstrong College), Liverpool University, and the Royal Naval College, Greenwich, for three years, and are open to British apprentices or students who have not yet entered upon a university course. Full particulars may be obtained from the secretary, Institution of Naval Architects, 5, Adelphi-terrace, London, W.C. 2.